PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	)	Group Art Unit: 2664
Maarten Menzo Wentink	)	Examiner: Ajit Patel
Serial No.: 09/943,803	)	Confirmation No.: 1389
Filed: August 31, 2001	)	Docket No.: 050337-1080
For: **SYSTEM AND METHOD FOR ORDERING DATA MESSAGES HAVING DIFFERING LEVELS OF PRIORITY FOR TRANSMISSION OVER A SHARED COMMUNICATION CHANNEL**	)	

DECLARATION OF MAARTEN MENZO WENTINK PURSUANT TO 37 C.F.R. §1.131

Commissioner of Patents
Alexandria, VA 22313-1450

Sir,

I, Maarten Menzo Wentink, hereby declare that:

1) I am over the age of 21 years. I have personal knowledge of the facts made in this Statement, and the facts stated herein are true and correct to the best of my knowledge and belief.

2) I have developed several inventions within the area of communications, including the following issued U.S. Patents which list me as an inventor:

U.S. Pat. No. 6,977,944	Transmission Protection for Communications Networks Having Stations Operating With Different Modulation Formats
U.S. Pat. No. 6,907,050	Method and Device For Charging Communications Based on RSVP Protocol
U.S. Pat. No. 6,791,962	Direct Link Protocol in Wireless Local Area Networks

3) I am the inventor of the invention disclosed in the above identified U.S. Patent Application directed to systems and methods for ordering data messages having differing levels of priority for transmission over a shared communication channel. I hereby submit my statement concerning the early date of the subject matter of the claims of this patent application. This is in effort to pre-date references that are dated prior to the earliest effective filing date of this patent application. The acts relied upon to establish the date prior to the reference were carried out in the United States, a NAFTA country, or a WTO member country.

4) I am advised that the United States Patent and Trademark Office has rejected one or more claims presently pending in the above-identified patent application based upon U.S. Patent Application Publication No. 2002/0163933 to *Benveniste* ("the *Benveniste* reference"). I am further advised that the earliest effective priority date of the *Benveniste* reference is November 3, 2000.

5) I began development of the invention before the earliest filing date of the *Benveniste* reference. This declaration and accompanying exhibits are submitted to show the early conception of the invention and the dilligent progress I made toward actually reducing the invention to practice.

6) In October 2000 through January 2001, I served on the Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.11 Task Group E, which serves to propose and standardize various improvements to the IEEE 802.11 wireless standard. Specifically, the mission of the 802.11 Task Group E during this time period was to address Quality of Service (QoS) issues within the 802.11 standard.

7) Some time before the effective date of November 3, 2000, I conceived of the invention claimed in this application. The invention related to ordering data messages having differing levels of priority for transmission over a shared communication channel which could be used within the 802.11 environment. The invention is now embodied in the present IEEE 802.11 standard under the feature set now known as Enhanced Distributed Channel Access (EDCA). However, in introducing the concept to the 802.11 Task Group E, the invention

was referred to as Virtual Distributed Coordination Function (VDCF or Virtual DCF).

8) As evidence that the present invention was so conceived before the effective date of November 3, 2000, **Exhibit A** includes a presentation that I submitted to the IEEE 802.11 Task Group E in October of 2000. The presentation sets forth how to enhance a Dynamic QoS (D-QoS) mechanism through the use of the VDCF mechanism embodied in the claims of this application.

9) As further evidence that the present invention was so conceived before the effective date of November 3, 2000, **Exhibit B** includes a second presentation that I submitted to the IEEE 802.11 Task Group E in October of 2000. The presentation sets forth differences between the VDCF mechanism and another proposed mechanism, Scheduled DCF.

10) I proposed the VDCF invention to the Task Group E workforce on October 18, 2000, as evidenced in the minutes set forth in **Exhibit C** (*See* page 13, §1.5.1.2). As evidenced further in Exhibit C, the VDCF proposal was discussed in several contexts of its potential incorporation into the D-QoS mechanism during the 802.11 Task Group E workforce meeting in New Jersey on October 24 – 25, 2000.

11) As evidence that the present invention was diligently pursued until actual reduction to practice, **Exhibit D** further evidences the minutes taken at an 802.11 Task Group E workforce meeting in Tampa, FL on November 6 – 10, 2000. Exhibit D shows that the VDCF proposal was discussed with reference to its potential incorporation into the D-QoS mechanism.

12) Further, **Exhibit E** includes a presentation given to the IEEE 802.11 Task Group E in November 2000. Exhibit E sets forth a baseline proposal for the D-QoS mechanism. The baseline proposal incorporates the VDCF concepts introduced in the presentations of Exhibit A and Exhibit B into the D-QoS standard. As part of the Task Group E efforts, Greg Chesson prepared a simulator that embodied concepts proposed to be incorporated within the D-QoS standard. Exhibit E, further states that future goals of the simulator were to include test results specifically using the VDCF concepts. *See,* for example, Exhibit E, page 49.

13) In January 2001, Greg Chesson did complete a simulator that embodied the VDCF concepts within the D-QoS standard, thereby actually reducing the invention to practice as reflected in **Exhibit F**. Exhibit F, labeled "Simulation Results for QoS, pDCF, VDCF, Backoff/Retry" and presented to the 802.11 Task Group E in January 2001, provides a number of test results generated from the simulator. *See* slides 11, 20 – 23, and 27 – 34, for example.

14) The 802.11 Task Group E discussed the VDCF concepts in ongoing teleconferences and meetings between its introduction in October 2000 and its eventual reduction to practice in January 2001. In addition, I was employed as a full-time engineer at Intersil, Inc. during this period of time. Between the IEEE Task Force Group E meetings and my full-time employment, there was very little opportunity to further develop or work on this invention during this period of time. However, I continued to communicate with Greg Chesson with respect to the invention until at least the invention's actual reduction to practice.

DECLARATION

I hereby declare that all statements made herein are of my own knowledge are true and that all statements are made on information and belief and are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2-15-06
Date

Maarten Menzo Wentink

EXHIBIT A

Enhance D-QoS through Virtual DCF

Maarten Hoeben, Menzo Wentink

Intersil

D-QoS Objectives

- Provide service differentiation
  - Without losing fairness (delay and throughput)
    - Both between classes of same priority as well as cross priority, both local and remote
  - Without increasing complexity too much
- Limit the delay for higher priority classes
  - Limit medium load
  - Avoid starvation of lower priority classes

DCF Properties

- DCF is a reasonable fair access mechanism, given that:
  - All frames are equal in size (throughput fairness)
  - Fairness is monitored over a longer period
  - All STAs use the same Contention Window (CW) settings
  - Near-far problem is not considered an issue
- Delay properties are reasonable if medium load is kept low
- Manipulation of CW allows for differentiation

D-QoS Concept

- Separate queues for each priority class
- Differentiate through per class CW settings and/or Submission Rate (SR)
- CW and SR are dynamically adapted to current medium load
- See presentation by Wim Diepstraten, Lucent for more details

D-QoS Access Mechanism Problems

- Fairness issues:
  - Throughput unfairness
    - Proposal does not solve intrinsic DCF problem
  - Possible unfairness between same priority classes of local and remote STAs
    - For example: if the local STA has frames in both high priority as well as low priority classes while the remote STA has frames in only low priority classes, the access distribution for the low priority classes is not the same

D-QoS Access Mechanism Problems (cont'd)

- Distribution not consequent within same local class
  - If a high priority queue empties, the new tx-opportunity rate distribution for a lower priority queue changes in an unpredictable way
- Difficult to predict behavior or analyze theoretically
- Granularity of service rate control is low
- Many tuning-parameters (backoff and service rate)

Virtual DCF

- Enhance D-QoS through "Virtual DCFs"
  - Model the queues of the priority classes in an STA as independent (virtual) DCFs
    - Each V-DCF contends for the medium independently of the other local V-DCFs
    - Solving a local collision between V-DCFs is a policy decision
    - Incase of a collision with a remote V-DCF, the CW for a retry is doubled for the colliding V-DCF only
  - Differentiate solely through CW differentiation (service rate not required)
  - Making CW also dependent of the total duration of the frame exchange for which the V-DCF contends will increase fairness

V-DCF Advantages

- Predictable and fair service differentiation
  - Decoupling of the entire fairness matrix (local-remote, high-low priority)
  - Decoupling of access mechanism from drop rate control because queue backlog does not influence distribution of access per class
    - Drop rate control does not have to be standardized because it is not coupled
- Allows for a simple solution of inherent DCF throughput fairness issue

V-DCF Advantages (cont'd)

- Low implementation complexity
- Easier to analyze than current D-QoS access mechanism
- Enhances D-QoS with a better differentiation method
  - All ideas of Lucent's proposal (Load monitoring and controlling, AP priority, drop rate control etc) are still applicable
- Fairer integration of legacy stations

V-DCF Issues

- V-DCFs increase the number of entities contending (up to 2007*8!). Is this a problem?
  - No, the intent of D-QoS is to keep the medium load reasonably low through rate control and increased CWs, so contention is less of an issue
  - Not all V-DCFs contend with the same (low) CW
  - The local V-DCFs avoid collisions
- Does the local (station internal) interaction of V-DCFs introduce unwanted side effects, such as fairness issues?
  - As analyzed so far, these side effects are minimal and do not impact the fairness noticeably

EXHIBIT B

Scheduled DCF vs. Virtual DCF

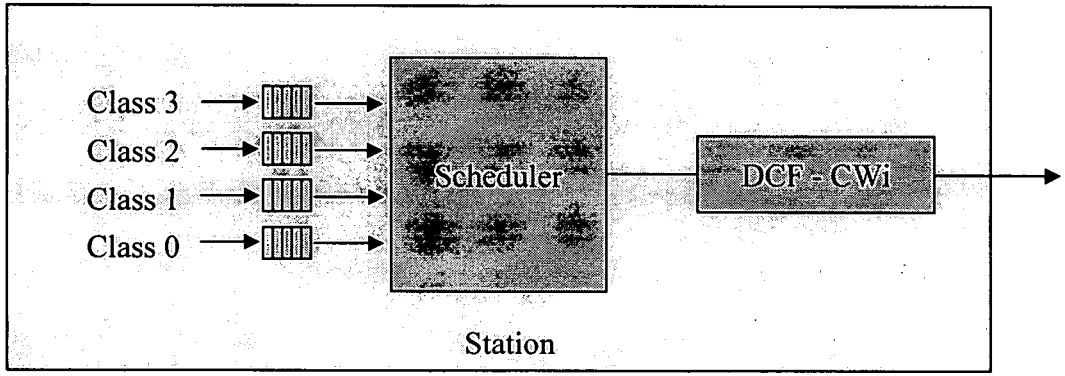
Maarten Hoeben, Menzo Wentink

Intersil

Goal

- To compare the two proposed D-QoS solutions:
  - V-DCF (Virtual DCF)
    - Each class has an independent Virtual DCF
  - S-DCF (Scheduled DCF)
    - Each station has one DCF which uses the CW for the highest backlogged class. An internal scheduler provides for rate adaptation in the case that more than one local class has backlogged traffic

Scheduled DCF

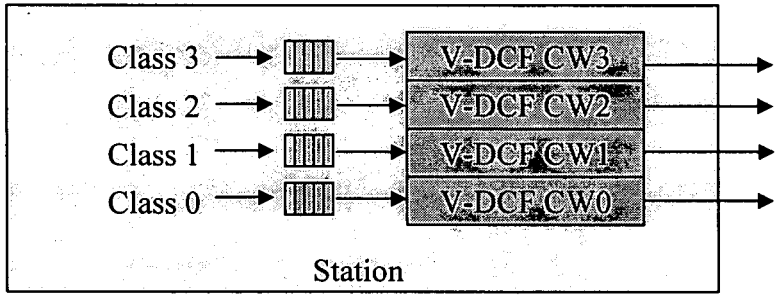


- S-DCF stations merge traffic from different classes in the scheduler, prior to sending the muxed stream into the DCF
- The DCF uses the CW value corresponding to the highest backlogged queue i (CWi). The CW values are controlled by the AP
- The scheduler can be vendor specific but the ratios are probably controlled by the AP

Scheduled DCF

- CONS
  - Stations must implement a scheduler → more complexity
  - Many variables must be controlled: CW and scheduler ratios.
  - Traffic from different classes is multiplexed in two different ways, which do not result in similar behavior:
    - Locally: in the Scheduler
    - Remotely: through the DCF
  - This will result in an intrinsically unfair system! – see example
- PROS
  - The number of contenders is the same as the number of stations

Virtual DCF



- Stations maintain a separate (virtual) DCF for each class.
  - CW values are controlled by the AP
- The V-DCFs (implicitly) merge the traffic

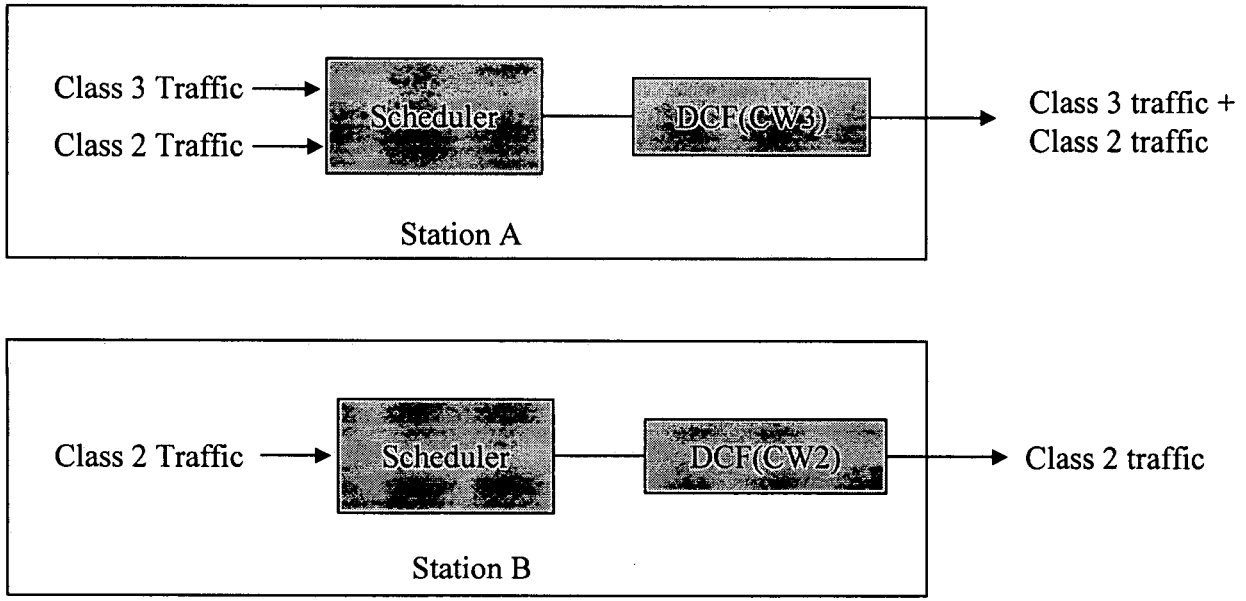
Virtual DCF

- CONS
  - Increased number of medium contenders, especially when classes are frequently used in parallel
    - But this is an advantage for the Access Point
- PROS
  - No scheduler required in stations, which reduces complexity
  - Predictable and fair inter-station behavior
  - Easy to understand conceptually
  - Smallest possible number of variables to be managed
  - Under the assumption that most stations will use only one class at a time, V-DCF is the simplest solution
  - The AP (which will usually have traffic in all of it's queues) becomes more aggressive

S-DCF Fairness Issue

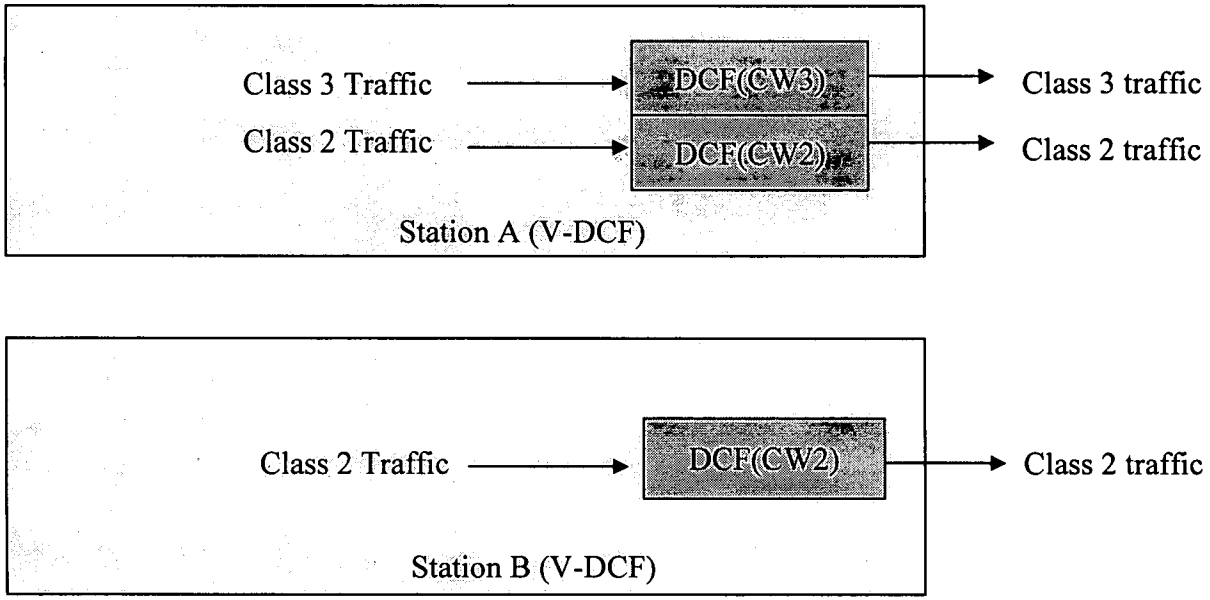
- Example:
  - Several stations are transmitting Class 2 traffic only. All S-DCFs use the same CW (CW2), so on average the individual streams will be equal in size.
  - One station starts transmitting Class 3 traffic also, while it keeps on sending the Class 2 traffic.
  - The S-DCF in that station will switch to a new CW (CW3) and start transmitting the Class 3 traffic, while it interleaves the Class 2 frames.
  - The Class 2 rates from other stations will automatically adapt to the presence of the additional Class 3 traffic, and the DCF again ensures that on average each Class 2 stream will be equal in size.
  - However, the Class 2 stream that comes from the station with Class 3 traffic will be determined by the *internal scheduler*. So while all Class 2 rates are (indirectly) determined by the ensemble of DCFs, there is one Class 2 rate which is determined by the scheduler. Theoretically that rate could be the same, but it is very likely that it is not.
  - This a a fundamental fairness issue with S-DCF.

S-DCF Fairness Issue (cnt'd)



- Fairness demands that the Class 2 traffic streams from station A and B are the same (statistically)
- The intrinsic problem with S-DCF is that traffic is multiplexed in two different ways: locally in the scheduler AND remotely by the DCF's.

Fairness in V-DCF



- DCF is a fair mechanism, so V-DCF is also

EXHIBIT C

IEEE P802.11
Wireless LANs

802.11 Task Group E Teleconferences

Date: October 24-25, 2000

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Minutes of IEEE P802.11 Task Group E Interim Meeting – New Jersey
QoS Baseline Development Ad Hoc

October 24-25, 2000

1.1. Opening

1.1.1. Called to order by John Fakatselis at 09:00

1.1.2. Secretary – Tim Godfrey

1.1.3. Roll Call

Harry Worstell – AT&T hworstell@att.com
Bob Miller – AT&T rrm@att.com
Dan McGlynn – Symbol mcglynn@symbol.com
Duncan Kitchin – Intel duncan.kitchin@intel.com
Wen Ping Ling – NextComm wying@nextcomminc.com
Matthew Sherman – AT&T mjsherman@att.com
Bob Meier – Cisco rmeier@cisco.com
Liwen Wu – Cisco liwwu@cisco.com
John Kowalski – Sharp kowalskj@sharplabs.com
Menzo Wentink – Intersil Menzo.Wentink@nwn.com
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Jin Meng Ho – TI jinmengho@ti.com
Greg Chesson – Atheros greg@atheros.com
Harold Teunissen – Lucent hteunissen@lucent.com

1.1.4. Procedural Notes

1.1.4.1. Ad Hoc meeting – not binding for TGe. We will generate an output document for TGe.

1.1.4.2. Voting rights – everyone has the right to vote. Attendance does not count towards 802.11 voting rights. Output documents are publicly available on the web site.

1.1.4.3. Lunch Logistics – buffet to be served in the meeting room.

1.1.4.4. This room is available in the evening.

1.1.4.5. Conference call – there is no phone available in this room. We will not have the conference call on Wednesday, or re-schedule it.

1.1.5. Objectives

1.1.5.1. Direction from TGe – this is a single subject meeting, to work on the baseline for the QoS draft. We will organize the outline, and structure the sub-section starting text. This output will be guidance for the November plenary meeting.

1.1.5.2. We are here to generate a baseline that is acceptable to >75% of the TGe in Tampa.

1.1.5.2.1. Identify the relevant topics

1.1.5.2.2. Define general solutions for most topics

1.1.5.2.3. Define specific behavior if time permits.

1.1.5.3. This is a baseline – not a draft. We do need to have something to adopt as a draft as soon as possible to accelerate our progress.

1.1.5.4. We will attempt to ballot the QoS and Security components together if possible. If their schedules diverge, they may need to be separated.

1.2. Agenda

1.2.1. Proposed Agenda

1.2.1.1. 09:00 Organize result capture

1.2.1.2. 09:10 Review objectives and non-objectives

1.2.1.3. 09:20 Output documents and style issues

1.2.1.4. 09:40 Choose order of technical discussions

1.2.1.5. 10:00 Technical discussions

1.2.1.5.1. Terminology – 15 minutes

1.2.1.5.2. MLME SAP – initialization issues – 30 minutes

1.2.1.5.3. MAC SAP Definition -

1.2.1.5.4. Issues with the PHY SAP, 802.11a issues.

1.2.1.5.5. DCF / PCF Extension Integration

1.2.1.5.5.1. Higher layers

1.2.1.5.5.2. Conformance Levels

1.2.1.5.6. Extensions to the DCF

1.2.1.5.7. Extensions to the PCF

1.2.1.5.8. Power Management / Multi-rate

1.2.1.5.9. Bridge Portal Concept

1.2.1.5.10. Overlapping BSS

1.2.1.5.11. Frame Formats (and FEC)

1.2.1.5.12. Other

1.2.1.6. 14:30 Generate text – small groups

1.2.1.7. 16:30 Assess progress, plan evening & AM

1.2.2. Agenda approved without objection

1.3. Technical Discussion

1.3.1. Output documents

1.3.1.1. Start from output of Scottsdale (00/332)

1.3.1.2. Include text from existing standard – complete document representing the 802.11 MAC.

1.3.1.2.1. We could handle clauses 1-5 with insertions

1.3.1.2.2. With clauses 6-7 and 9-11 we should include and update the existing text for readability

1.3.1.2.3. We should add a new clause 19 on QoS. (overview and new normative material)

1.3.1.2.4. We also need to perform maintenance on all MAC clauses to merge in 802.11 a, b, and d, and correct known errors and ambiguities.

1.3.1.3. This output document structure was accepted without objection

1.3.1.4. Proposal for a separate document to capture multiple alternatives that are not incorporated into the baseline. (starting from today).

1.3.1.5. Instead of generating a separate document, we will capture alternative ideas in the minutes.

1.3.1.5.1. Accepted without objection

1.3.1.6. Output documents:

1.3.1.6.1. Baseline Proposal

1.3.1.6.2. PowerPoint presentation for Tampa – to present the baseline to the TGe group in a more understandable form.

1.3.1.6.3. Usage Suggestions – preliminary draft of material for the informative annex (use with SBM, RSVP, 802.1D and Q). Document 00/357

1.3.1.6.4. Errors and Ambiguities in the 802.11-1999 MAC specification (needed by the end of the November meeting.) (document 00/353)

1.3.1.6.5. 802.11a PHY timing required by the 802.11 MAC. (00/354)

1.3.1.6.6. Record of rejected proposals (00/355)

1.3.1.7. Result capture strategy (volunteers needed)

1.3.1.7.1. Topics that are important to explain to TGe – Greg Parks

1.3.1.7.2. Terms, acronyms and intended meanings – John Kowalski

1.3.1.7.3. errors and inconsistencies in existing standard. – Michael Fischer

1.3.1.7.4. These documents to be merged into the minutes.

1.3.2. Terminology

1.3.2.1. Consistency with 802.11 and 802.1 is important.

1.3.2.2. The PCF and DCF definitions: coordination functions- they are mechanisms, not services There is one service – asynchronous data service. We are not creating any new services.

1.3.2.3. We need a way to refer to the "things" that differentiate QoS. The term "traffic class" is bad because our use conflicts with the 802.1 usage of this term. We can't re-define it.

1.3.2.4. The terms "Traffic Label" and "Traffic Category" is proposed.

1.3.2.5. "Traffic Category" is the preferred option. (Leaving "traffic label" for the field that carries this information)

1.3.2.6. We need terms for enhanced versions of things (ESTA, EAPC). The terms in the Joint proposal are suggested.

1.3.2.7. Transmission Opportunity – defined as a time and duration limit (under rules of the coordination function in effect) where a station has the right to transmit.

1.3.3. MLME SAP

1.3.3.1. Initialization of a QBSS

1.3.3.1.1. MLMEstart.request could be extended by adding another type – namely QBSS.(QoS infrastructure and QoS Independent)

1.3.3.1.2. Capability information would need to reflect Capability bits as appropriate.

1.3.3.1.3. A parameter set will need to be defined (QBSS parameter set)

1.3.3.1.4. No discussion – will be an editorial activity. Add "QoS_Infrastructure" and "QoS_Independent" to BSSType.

1.3.3.1.5. We need a new parameter of "QoS_Level" (could be implicit in capability bits)

1.3.3.1.6. Editorial note: The restriction about advertised vs granted capabilities.

1.3.3.1.7.

1.3.3.2. Initialization of Bridge-Portal

1.3.3.2.1. Additional parameters are needed in "join".

1.3.3.2.2. new MLME-BP-Start.request / .confirmation

1.3.3.3. Scan / Join by a station (ESTA)

1.3.3.3.1. Add "QoS_Infrastructure" and "QoS_Independent" to BSSType.

1.3.3.3.2. Use capability bits to identify QoS_Level in both the MLME-join.request and join.confirm.

1.3.3.4. Reporting of WM state to higher layers

1.3.3.4.1. an abstract interface

1.3.3.4.2. Is the higher layer asking for medium status, or is it told medium status? Consensus it that it is asking.

1.3.3.4.3. This means the MLME-WMStatus.request and .confirm are needed.

1.3.3.4.4. Exactly what about the medium would be reported? Instantaneous state of medium – no contracts or guarantees.

1.3.3.4.5. List of potential parameters is still needed….

1.3.3.5. New primitive to allow Error Statistics for a particular multicast MAC Address to be provided from a higher layer to the MAC. The MAC cares so it can make a determination of the best data rate.

1.3.3.5.1. This could also be done with an extended vector on MLME-Set or in MIB parallel to dot11MultcastAdddrList

1.3.3.6. Discussion

1.3.3.6.1. Does the AP need to announce its capabilities in a general sense and what is currently available separately? Or is denial of capabilities at time of association due to inadequate resource acceptable?

1.3.3.6.2. How does a station find out what the maximum capabilities of an AP are (if the advertised level is lower due to resources)?

1.3.3.6.3. Resources and Capabilities are two different things, and should not be overloaded onto one set of bits.

1.3.3.6.4. When a station is rejected for association at a certain level, can it allow associate at a lower level before that level is advertised in a beacon?

1.3.3.6.5. Suggestion to put the AP's state into the load element. It would allow the station to determine why association is denied, and alter the request if possible in order to obtain association.

1.3.3.6.6. Capability bits to remain unchanged during the operation of the QBSS. General agreement on this point.

1.3.3.6.7. We need to figure out the best mechanism for communicating the state of the AP for stations to use when attempting association.

1.3.3.6.8.

1.3.4. MAC SAP definition

1.3.4.1. We cannot change the MAC SAP. The higher layers don't know about any additional parameters. Applications shouldn't need to know if they are associated in a QBSS or legacy BSS.

1.3.4.2. Proposed Text and notes:

1.3.4.2.1. Presented by Duncan Kitchin.

1.3.4.2.2. Explanation of the nested QoS Level concept will be put in Clause 19.

1.3.4.2.3. This is a single data service description. The QoS Functions must be defined in a formal way, in spite of the lack of guarantees due to the wireless medium.

1.3.4.2.4. Semantics of the service primitive – mostly prescribed by 802.

1.3.4.2.5. The priority parameter used to be Contention and Contention Free. The new parameter continues to support Contention and Contention Free, and adds an integer between and including 0 to 7.

1.3.4.2.5.1. The preferred approach is to map Contention and Contention Free map to integer values, or both could be mapped to "best effort" at a QoS capable station.

1.3.4.2.6. Service Class has to do with ordering. It is specified and should not be touched.

1.3.4.2.7. Add new status parameter for "unsupported priority" which will be properly generated by existing equipment. Return "unsupported priority" for priorities other than contention and contention free in the case the MAC is not capable of supporting QoS greater than level 0.

1.3.4.2.8. The philosophy of always attempting delivery rather than rejecting should be communicated in the TGe presentation.

1.3.4.2.9. Note- We need to make sure the Clause 8 revision from the Security sub group matches what we put in 6.2.1.2.3. We need to insure consistency with "security policy"

1.3.4.2.10. Expanding the reason for MA-UNITDATA-STATUS.indication value "k" – the local MAC doesn't have the required credentials or other security data to transmit the frame.

1.3.4.2.11. We need to fix value "b and i" also. We need to make a note that it will never be reported.

1.3.4.2.12. We need to clarify that there is a difference between "undeliverable because" and "not delivered at requested priority"

1.3.4.3. Does anyone object to adopting this text, with appropriate editorial updates?

1.3.4.3.1. No objections

1.3.4.4. The way 802.1 defines integrated services has an internal meaning to 802 as in 802.6, which is different than our use.

1.3.4.4.1. Suggestion to use "Parameterized Services".

1.3.4.4.2. Unanimous agreement.

1.3.4.5. At level 3 QoS, we have a QoS Parameter set that applies to a context of a given address, direction, and category label.

1.3.4.6. Suggestion that "traffic specification" replace the term "QoS Parameter Set". It is what the external entity specifies at the MLME SAP.

1.3.4.6.1. This is good because it separates the meaning of the traffic specification, and the QoS parameter set element, which carries the "traffic specification".

1.3.4.7.

1.3.5. PHY SAP and 802.11a issues

1.3.5.1. Is this just an 802.11a issue? No it is definitely relevant to QoS.

1.3.5.1.1. The 802.11 PAR defines a single MAC and multiple PHYs. By definition, if there is a conflict between a PHY and the MAC, the PHY is wrong.

1.3.5.1.2. The standard says in 11.1.2 that the TSF timers are synchronized within 4uS across the BSS.

1.3.5.1.3. There is no evidence that we enforce this, the range will become +/- 8 in 802.11a BSSs.

1.3.5.1.4. If TSF is only used for power save and frequency hopping TSF accuracy is not an issue. If we are trying to schedule TxOps, or other mechanisms, we have an implicit guardband, where the timing must be based on TSF, since that is all that is available for synchronization..

1.3.5.1.5. We may need to specify that PHYs shall conform to certain limits for timing accuracy.

1.3.5.1.6. It doesn't effect frame exchange sequence, but does effect everything else that uses timings longer than SIFS.

1.3.5.1.7. We have to make it clear that 802.11a must meet the required timing. We cannot allow data rate dependant SIFS definitions.

1.3.5.1.8. We need to specify a set of numbers that will allow the MAC to work properly.

1.3.5.1.9. Defer discussion of 802.11a to Tampa after Michael makes his submission on this subject.

1.3.5.2. We are not going to introduce the concept of PHY dependent TSF synchronization

1.3.5.3. We have a place holder in 00/332 for the concept of MAC layer FEC. It is an open issue whether FEC at the MAC is worth the complexity.

1.3.5.3.1. Defer this discussion to the Frame Formats section.

1.3.5.4. Ambiguity in the current standard – the concept of PIFS has difficulties with DS PHYs. There is no guarantee that you will have any indication of CCA soon enough for PIFS. No CCA by the PIFs boundary is not a reliable indication that there is no activity, and could cause collisions.

1.3.5.4.1. We need to raise this issue when we are working on Clause 9.

1.3.5.5. Are there any other things needed for the service field in 802.11a? Anything to piggyback? Potentially it could be used as a feedback mechanism for power control.

1.3.5.6.

1.3.6. Integration – Higher Layers and Conformance

1.3.6.1. The use of PCF and DCF is at the discretion of the MAC, even in the existing standard. Even if contention free was specified, the MAC is not required to use PCF to deliver it.

1.3.6.1.1. We cannot change the existing behavior of the PCF, but we can enhance it. We can specify a overlapping BSS mitigation mechanism. There are proposals for this. This has its own agenda item.

1.3.6.1.2. We need to put this aside until we have a proposed algorithm so it doesn't delay the baseline. Such a proposal could change the rules under certain (overlap) conditions.

1.3.6.1.3. We agree that we are continuing on the lines that we have PCF and DCF that behave no worse than the existing standard (regarding lack of channels and BSS overlap). We are not going to delay the baseline to come up with a completely new coordination mechanism.

1.3.6.2. Normative text has nothing to say about higher layers except at the SAPs. However we need to explain how this MAC works with 802.1d/q, intserve, diffserve, RSVP, etc. We need descriptive text in an informative annex to prevent confusion and comments at ballot time.

1.3.6.2.1. 802.1d annex H describes mapping 8 levels into less than 8 queues. We will refer to this as an example. Queues must be FIFO due to ordering requirements.

1.3.6.2.2. In level 3 you could have an arbitrary number of queues. It is an implementation issue. You don't need to quantify what a given priority level actually means.

1.3.6.3. Given our level 1, 2, and 3 QoS, what structure can we give to the document?

1.3.6.3.1. In levels 1 and 2 there are 8 or fewer queues.

1.3.6.3.2. in Level 3, there are 8 or fewer queues per endpoint.

1.3.6.3.3. Between level 1 and 2 the only difference is the channel access function is the only difference, the scheduler is the same.

1.3.6.3.4. The standard does not require but does not preclude the scheduler from using information from the channel access function.

1.3.6.3.5. The scheduler should not be standardized. It does need to be addressed because we need to determine whether an AP that claimed to implement QoS actually did so, from a conformance testing viewpoint.

1.3.6.3.6. For D-Qos the backoff behaviors may be split between the channel access and the scheduler.

1.3.6.3.7. What is our definition of fairness? Includes the concept of packet length (air time).

1.3.6.3.8. Is there an intent to have a normative definition of fairness? Between stations is the only place fairness should matter.

1.3.6.3.9. Ultimately, the MAC is to provide fair sharing of time on the medium.

1.3.6.3.10. There is a need for a variant of SBM in the clients to help manage the allocation of time. <<<<<

1.3.6.3.11. If the rate changes, the allocations have to be re-negotiated.

1.3.6.3.12. It is possible to define behaviors that exist at the air interface that can be verified for PICs. There could be a measurable fairness test based on this, although it is not necessary.

1.3.6.4. Can we put in new mechanisms that all stations from this point going forward will have to comply with? Indirectly we can do that, as far as it is a part of 802.11E. We do not have a PAR to withdraw anything in the 802.11-1999 MAC. 802.11E does not supercede 802.11-1999.

1.3.6.5. How does a retried low priority packet get handled with respect to a high priority packet in the queue? The scheduler selects a packet for a TxOp. If it fails, it will be retried when the scheduler submits it to the channel access mechanism.

1.3.6.6. We need to set some bounds on the behavior of the scheduler, but not fully specify it.

1.3.6.7. For the D-QoS proposal it is essential that the scheduler behave the same at each station. The channel access mechanism must behave in a manner that appears the same on the air interface. The objective is to achieve equivalent handling of a given priority between stations.

1.3.6.8. We have concluded that it would be difficult to specify in the PICs anything that would distinguish between an empty scheduler and an non-empty scheduler.

1.3.6.9. One remaining issue (not to spend too much time on) – the four conformance levels. Do we want to open that again?

1.3.6.9.1. Straw Poll – 6 want to discuss.

1.3.6.9.2. Clarification of what needs to be discussed.

1.3.6.9.3. Request to concisely state the policy and philosophy of what was agreed to.

1.3.6.10. Misconception 1 – the purpose and intent of this standard. We need to insure that any 802.11E device can talk to any other conformant 802.11E device.

Level 3		*EPCF + CP*
Level 2		

Level 1	1A – EDCF	1B – EDCF
Level 0 (802.11-1999)	DCF	DCF+PCF

1.3.6.11. TGe Objective Review – Duncan Kitchin

1.3.6.11.1. HiperLAN 2 has an advantage in QoS

1.3.6.11.2. We did consider adopting the channel access mechanisms of HiperLAN2 into 802.11a, but it was not practical from a compatibility

1.3.6.11.3. Each QoS level is a strict superset of those before it.

1.3.6.11.4. HiperLAN has disjoint, non-interoperable network "styles". (because of the convergence layers)

1.3.6.11.5. We decided that anything that is 802.11 compliant with QoS (802.11E), can talk to anything else that is 802.11E, with better performance than legacy 802.11.

1.3.6.11.6. Can a level 3 device talk to a level 1 device? It either would go through the AP, or it could be peer-to-peer using level 1 QoS.

1.3.6.11.7. It would be possible for an application to refuse to work if the required level is not available on the network.

1.3.6.11.8. Why the levels must be nested – imagine a level 1 AP, with a level 2 station. If the level 2 station can't support level 1 Qos, it will have no QoS ability at all.

1.3.6.11.9. The premise was that level 1 provides 8 queues, with the implementation of enhanced DCF TBD. A radically new redesigned channel access function is not in the spirit of the enhanced DCF charter.

1.3.6.11.10. Is it worth implementing multiple queues without changing the channel access? Maybe

1.3.6.11.11. How does an application sense what kind of QoS level is present? It indicates in the BSS descriptor for the Scan Request. How the application gets to the MLME SAP is outside our scope. Some may be in the MIB also.

1.3.6.11.12. There has been an assumption that the enhanced DCF should be able to work in an ad hoc network.

1.3.6.12. Clarification of the "QoS levels" decision on October 4.

1.3.6.12.1. Level 0 – non QoS 802.11-1999

1.3.6.12.2. Level 1 – enhanced DCF, 8 priorities (existing DCF or simple enhancement)

1.3.6.12.3. Level 2 – Adds a PCF with 8 priorities, a proper superset of level 1

1.3.6.12.4. Level 3 – adds Traffic Categories, with 8 per endpoint address.

1.3.6.13. Concern over complexity of DCF QoS enhancements. It was deferred until we have a proposal for the EDCF mechanism.

1.3.6.14. The only open issue is what does a level 2 or 3 AP do in its contention period? Does this justify spending any more time? Nobody has to implement more than level 1 to be 802.11E conformant.

1.3.6.15.

	Channel Access	Scheduling Policy
Level 3	EPCF w/ DCF	Parameters
Level 2	EPCF w/ DCF	Priorities
Level 1	(E*)DCF	Priorities
Level 0 (802.11-1999)	DCF legacy	Priorities

* DCF enhancements TBD – could be none at all.

1.3.6.16. There will be a bigger difference between level 1 and level 2 than there will be between level 2 and level 3. The EPCF lets you control latencies and jitter.

1.3.6.17. An additional difference between L1 and L2 is more efficient use of the medium, more time to send useful payload. The gain at L3 with parameterization is not yet known. In L3 you can differentiate 8 categories per destination, which enables additional improvements in efficiency.

1.3.6.18. 802.11 could address a seminal market with end-to-end QoS in the home network / service providers. This could be an alternative to 3G in campuses and buildings. The number of PCMCIA slots will be limited in comparison. Users will oscillate between home and office applications, and would like to use the same equipment in both.

1.3.6.19.

1.3.7. Straw Poll

1.3.7.1. To determine if we need more time for discussion.

1.3.7.2. Did we adequately clarify the points?

1.3.7.2.1. Everyone except 2 people are clear.

1.3.7.3. Do we agree that this "nested level approach", as clarified above, is the way to proceed.

1.3.7.3.1. The concept of DCF enhancement is not central to the nesting. If we adopt this, it is appropriate to say a DCF enhancement is not good.

1.3.7.3.2. Straw Poll – 13 people in favor of the nested level approach, 9 are abstaining or waiting until after the DCF discussions.

1.3.8. DCF Extensions

1.3.8.1. There has been a great deal of work, which could be seen as not converged enough. We should decide the approach – a more general approach to DCF enhancement for presentation at Tampa, or a snapshot of what we have now?

1.3.8.2. We can't write baseline text around something that isn't decided yet.

1.3.8.3. We have two or three E-DCF proposals. They differ in the internal scheduling and are similar in channel access.

1.3.8.4. In this time, can we converge enough to start writing text? No, but a small group could.

1.3.8.5. If this area is contentious it could derail us in Tampa.

1.3.8.6. Could we do something else in parallel to allow the DCF proposals to be converged? Proposal to discuss Power Management in parallel with the DCF discussion (Menzo, Duncan, Wim, Harold, and Greg to work on DCF)

1.3.8.7. DCF discussions to be re-opened with the whole group tomorrow morning at 08:30.

1.3.9. Power Management / Multi-rate

1.3.9.1. Is there anything left on multi-rate that was not discussed earlier in the 802.11a PHY discussion? No

1.3.9.2. Key point – there are three dimension in this space.

1.3.9.2.1. Objective – the radios of this type consume as much power in RX as in TX. You need to turn RX off without looking like you're disconnected from the network. How much do we do to incorporate power save in a QoS BSS? QoS applications are often not candidates for Power Save.

1.3.9.2.2. The cordless telephone model – aggressively saves power in standby, but not while operating.

1.3.9.2.3. Direct Station to Station communication – Today this isn't a problem since all traffic goes via the AP. This eats up bandwidth when going station to station. There is benefit, and it is easy to add (doc 00/254). If Sta-Sta is allowed, there is a new condition – it is only allowed between active stations. The revised joint proposal has a "listen epoch" but it does not generalize to the layer 1 and layer 2 QoS scenarios. We don't have a proposal for STA-STA power management that work in all level scenarios..

1.3.9.3. How do power save stations hurt QoS? In a PCF, all buffered Power Save traffic must be sent after the DTIM. The Point Coordinator is required to send PS traffic immediately after the beacon. This increases jitter.

1.3.9.4. We could decide to change the normative behavior of an EAP and an EPC to improve QoS at the expense of Power Savings. (most power save implementations are using DCF with PS-Polls).

1.3.9.5. Discussion on Power Save and direct STA-STA.

1.3.9.5.1. The original power save came from warehousing transaction oriented applications.

1.3.9.5.2. There was no concern for QoS.

1.3.9.5.3. We don't have to worry about breaking the existing mechanism when QoS is not in use.

1.3.9.6. The problem is we don't have an advocacy for power save. If we propose a baseline PS mechanism that simply says if you use QoS categories you can't go into power save mode.

1.3.9.7. Another approach would be to allow a station doing a QoS association to inform the AP at association time that it wanted to use power save. Entering PS would only be allowed after the STA explicitly informs the AP.

1.3.9.8. The listen epoch was an attempt to define a specific time for a station to be listening with respect to the beacon. It was handled as part of the scheduling of streams. The problem is that at any level except 3, you don't have the concept of bilaterally identifiable categories. They are global to the BSS. So Listen Epoch doesn't work because even if you know when the other STA is awake, and a category is reserved for PS, to have any idea who might be the recipient.

1.3.9.9. At level 1, there is no concept of a TXop. If you follow the DQoS model, the scheduler will take the top of the queue, regardless of PS state.

1.3.9.10. Video has clear advantages in direct STA-STA, but it is not a clear candidate for power save. Perhaps we could prohibit direct STA-STA with QoS to use power save modes.

1.3.9.11. There is a strong interest in not giving up Power Save to have QoS. The aggressive Power Save applications are not using QoS. But, portable devices running on battery want QoS also.

1.3.9.12. It is ambiguous in today's standard whether STA-STA is allowed in a PCF. It should be allowed in an editorial update to clarify the issue.

1.3.9.13. The Listen Epoch method was proposed to deal with STA-STA with power save. Continuum from most to least complex:

1.3.9.13.1. Enhanced PCF Power Save w/ Listen Epoch plus Direct STA-STA (level 3 only)

1.3.9.13.2. Listen Epoch only via AP

1.3.9.13.3. Active Mode with > best effort

1.3.9.13.4. No QoS during Power Save

1.3.9.14. DCF power save continuum:

1.3.9.14.1. Power save, non-polling

1.3.9.14.2. DCF Power Save as it is today (no QoS during Power Save)

1.3.9.15. Straw Poll – who would endorse "Listen Epoch Only via AP" for PCF and Legacy only for DCF? 4 for, 3 against, 5 abstain.

1.3.9.15.1. For the no voters, they would prefer to have something to address power save with direct STA-STA.

1.3.9.16. Straw Poll – Is adding the PS direct STA-STA support intended for high offered load, or for high QoS sensitivity clients? It is really both. The question is – is there any savings compared to going from standby to active mode for video streams. Is the complexity of developing this PS option worth the benefit?

1.3.9.17. Bridge Portals (repeaters) are not assumed to ever need to power down (assume they use line power).

1.3.9.18. Listen Epoch as defined in Joint Proposal 00/120. A predefined interval where the station is known to be awake. (avoiding having to announce in the DTIM)

1.3.9.19. Capture progress:

1.3.9.19.1. Nobody is asking for an improvement to the DCF power save mode. We leave DCF power save alone. No Objection

1.3.9.19.2. For Level 2 it is seen as acceptable to use the "Listen Epoch only via AP" power save in PCF.

1.3.9.20. Differences from Level 3 in Joint Proposal – you have to use directed probe. Without VSIDs as an index there is a large amount of state space with 50 bit identifiers. Perhaps the Listen Epoch is not static, but a new element in the probe response.

1.3.9.21. Potentially, a PS station could be sensed with directed probes. First a direct STA to STA probe would say if the other station is awake. Sending the probe via the AP would buffer it and send it when the STA is awake, thus indicating that the STA is indeed in range and just sleeping.

1.3.9.22. Most of the complexity of level 3 is at the AP. The differences at the station will matter only in a narrow range of QoS environments.

1.3.9.23. Consider this to be adopted provisional on Michael to address this before tomorrow morning.

1.3.9.24. Who gets to choose the listen epoch? The AP or the PS STA? (the station might know how much bandwidth is needed).

1.3.9.25. The epoch is set up with a directed management frame exchange.

1.3.9.26. The proposal has a 32 bit bitmap to indicate the awake interval times in the beacon interval.

1.3.9.27. There is an assumption – if there are multiple streams of significantly varying data rate, this proposal won't really help, because of the overlapping intervals. This should be a minor concern.

1.3.9.28. Adjourn for evening

1.4. Opening Wednesday

1.4.1. Agenda Update for morning

1.4.1.1. DCF Extensions – 1 hr

1.4.1.2. Bridge Portals – 1/3 hr

1.4.1.3. PCF Extensions – 1/3 hr

1.4.1.4. BSS Overlap – 1/3 hr

1.4.1.5. Frame Formats – 1 hr

1.4.1.6. Other / Misc – ½ hr

1.5. Technical Discussion

1.5.1. Distributed DCF resolution – Wim

1.5.1.1. Agreement and resolution was achieved

1.5.1.2. Virtual DCF was the basic mechanism, as in the Oct 18th proposal.

1.5.1.3. vDCF would be used as the scheduler in level 1 and level 2 stations.

1.5.1.3.1. From the point of view of the station, all the mechanisms here would be in the station, and would also support level 1.

1.5.1.3.2. The TXop is treated the same whether it comes from a Poll or a DCF channel access

1.5.1.4. Fairness definition – statistically equal tx-op probability ; any pair of packets in the same queue from different stations will have the same probability of obtaining the medium.

1.5.1.5. In a level 2 station in a PCF, the AP generates the TxOps as Polls. In level 1, the station determines TXOps with the parallel backoff mechanism.

1.5.1.6. Multiple DCFs running in parallel, with individual counters for backoff and post-backoff.

1.5.1.7. Issue with Station Retry counter with multiple vDCFs.

1.5.1.7.1. We need to make sure that the text is clear that the Station DCF counters are one per station, but the virtual counters are per queue.

1.5.1.8. Functionally there are multiple counters, but they could be implemented with a single counter and offsets.

1.5.1.9. Discussion on question: How do you prevent starving the low priority?

1.5.1.9.1. This is taken care of by the probabilistic access mechanism. A low priority queue will get access, but at some fraction of the higher priority, due to the (intentional) differences in their base contention windows.

1.5.1.10. How is the post-backoff dealt with? There may be an issue.

1.5.1.10.1. The backoff procedure is executed after every transmission which is stated to provide a minimum of one backoff between successive transmissions by the station

1.5.1.10.2. After a collision, the post backoff increases the window and selects a backoff.

1.5.1.10.3. The post backoff should be a part of the PHY, not each vDCF, or the separation of transmission from a station by a backoff would not apply.

1.5.1.11. the AP should be allowed to concatenate multiple frames in one TX-op (similar to fragmentation)

1.5.1.12. Stations can also be allowed to send a burst, limited to a MaxMPDU size. (2304 bytes)

1.5.2. Discussion on DCF

1.5.2.1. Some implementations may not want to pass DCF control parameters, in the case of PCF oriented BSS. We may need a corresponding element set for the PCF cases.

1.5.2.2. If you are using the load monitor function, but don't put the values in the beacon, QoS stations wouldn't have benefit of that information.

1.5.2.2.1. Matt Sherman to coordinate with Michael to insure the proper elements are added to the draft.

1.5.2.3. Proposal that the AP could use the PIFS to access the medium to more highly prioritize the AP, given that the AP has an internal scheduler.

1.5.2.3.1. Comment – PIFS is ambiguous, this is not a good idea. The backoff is after the DIFS, so this only makes a difference if the backoff count is 1.

1.5.2.4. Is CWmax different for each queue? Probably – it is a multiplier factor for queue separation.

1.5.2.5. Will there be retry limits on a per queue basis? Yes.

1.5.2.6. Is this vDCF seen as an implementation burden?

1.5.2.6.1. Need to see it all in writing first – but comfortable so far.

1.5.2.6.2. The scheme looks fairly simple, but we need pseudo code and simulation results.

1.5.2.6.3. The concern is creeping elegance.

1.5.2.6.4. Is the load monitor required in the AP in level 1 and level 2? Yes, but all the work will be needed for a PCF anyway.

1.5.2.6.5. Will the format of the TIM change? No – backwards compatibility prevents it.

1.5.2.7. Action item – the PCF group needs to work on any additional elements that they need beyond the DCF elements for level 2.

1.5.2.8. Action item – DCF group to provide pseudo code for the access mechanism. The PCF group will add it to their simulations.

1.5.2.9. Greg C - We need a complete specification of the protocol to insure all the implementers questions of interpretation are answered.

1.5.2.9.1. The scope of 802 limits us in what can be in normative text. In the DCF the channel access mechanism needs to be tightly specified. For example, 802.3 has Pascal Pseudo code for access.

1.5.2.9.2. How do we compare relative complexity?

1.5.2.9.3. What are we doing the pseudo-code in? Something like C. The purpose is to expose the algorithm.

1.5.3. Straw Poll recap

1.5.3.1. How many think that the "level approach" is reasonable?

1.5.3.1.1. How many support? 13

1.5.3.1.2. How many don't support? none

1.5.3.1.3. How many abstain (undecided)? 6

1.5.3.2. Discussion

1.5.3.2.1. This is the first time we have no objection, so we are moving in the right direction

1.5.3.2.2. There is one dangling piece to clarify while we are here – when we discussed the 4 level scheme, and how 2 capability bits are assigned. It is not possible to represent the case of a level 2 station and level 1 AP unless we add more capability bits.

1.5.3.2.2.1. Are we already to the point of saving one bit? We have had debate over keeping capabilities only in this field.

1.5.3.2.2.2. Straw Poll – unanimous approval of adding an escape mechanism to the capability field.

1.5.3.2.2.3. We need to decide if we **require** the capability bit escape mechanism, or just keep it for future use. We could leave one bit.

1.5.3.2.2.4. Do we need to allow a legacy Point Coordinator in a BSS? We are not preventing compatibility with the existing standard.

1.5.3.2.2.5. The question is whether a level 1 BSS can support a legacy AP.

1.5.4. PCF Extensions

1.5.4.1. In Scottsdale, we had an ad hoc session where we looked at the EPC, based on the joint proposal. We discussed mechanisms for BSS overlap mitigation (a separate subject)

1.5.4.1.1. There are a set of mechanisms defining the TxOps and encoding the duration ID field which seemed to have no objections

1.5.4.1.2. We need to translate VSIDs to traffic categories as presently defined

1.5.4.2. Remaining categories to work on:

1.5.4.2.1. Opportunistic continuation with non-final bit.

1.5.4.2.1.1. There is a way to deal with this (re document 286)

1.5.4.2.2. There is a remaining area in the interaction of PCF and Power Save. We have a mechanism we worked out last night.

1.5.4.2.3. Since the flaws were found in the Joint Proposal power save, there has been no clear basis for why a schedule frame is useful. There is no understanding of what it is there for anymore. It has never been discussed. Where does this stand?

1.5.4.2.3.1. Take this off line – the editor has not received any reason why it is needed, despite asking the proposer several times.

1.5.4.3. Clause 9.3 is a description of something that exists once per BSS. Other than cleaning up the ambiguities, the editor proposes the EPCF is in a new sub-clause, since it is one or the other in a given BSS.

1.5.4.3.1. Unanimous agreement on this approach.

1.5.4.4. Comment - To make the PCF work, we need to be able to run at a high CFP rep rate. CFPmaxduration is based on MAXmpdu time. There is a definition problem on how it is represented.

1.5.4.4.1. There are two separate issues:

1.5.4.4.2. The question of what needs to be done with 9.3 regarding ambiguity

1.5.4.4.3. The question of the CFPduration for the EPCF? What is needed? CFPmaxduration is there to allow time for stations to associate.

1.5.4.4.4. Can we delete the minimum value for CFPmaxduration?

1.5.4.4.5. Take off line to email

1.5.4.5. Following a DTIM, broadcast and multicast traffic will be transmitted in a legacy system. This could consume the CFP.

1.5.4.5.1. We can't change legacy PCF. We already decided to relax this timing in the EPCF.

1.5.4.5.2. A PC could decide to delay some BC and MC traffic and not be non-conformant.

1.5.4.5.3. We don't want to preserve absolute priority of PS traffic over QoS traffic. We have a mechanism to deal with this.

1.5.4.6. There is a chance of beacon delay from contention period traffic. After beacon transmission, after a SIFS, the PC can transmit.

1.5.4.6.1. Proposal to delay the start of the CFP until the channel becomes idle.

1.5.4.6.2. This means the PC waits a PIFS after the beacon and sensing the channel before the PC transmits again.

1.5.4.6.3. This helps in the case where another transmission collides with the beacon transmission due to TSF timing uncertainty. It is possible, but not probable.

1.5.4.6.4. Perhaps a better way is to delay the beacon from TBTT to compensate for the NAV uncertainty. Adding one slot.

1.5.4.6.5. Question – is this perceived as a generally important enough case to have a special mechanism to protect against it?

1.5.4.6.5.1. If this happens, it is really bad.

1.5.4.6.5.2. If it happens, when does the PC find out? When it expects an ACK.

1.5.4.6.5.3. If the PC doesn't get an ack after a poll, it *may* resume transmitting after a PIFS. You are *allowed* to wait longer and sense the channel.

1.5.4.6.5.4. Is there any objection to having a normative fix for this case? No Objection.

1.5.4.6.5.5. The details will be taken off line between Sunghyun and Michael.

1.5.4.7. Can Table 22 be cleaned up?

1.5.4.7.1. This is not germane to the EPCF. But submit any proposal to Michael. It can't be removed or changed, because it is for the legacy PCF.

1.5.5. Bridge Portal

1.5.5.1. Is there a section for this in the standard?

1.5.5.1.1. Yes, it is not in the existing standard.

1.5.5.1.2. In the current standard in clause 5 has a concept that the integration service exists at one and only one place.

1.5.5.1.3. There was never a usage scenario to need a point of infrastructure attach different than the AP location.

1.5.5.1.4. We now have such a scenario in a home network with cable boxes, and APs at a different location for coverage reasons.

1.5.5.2. The WDS concept allows this, but an MLME function is needed to start this.

1.5.5.3. Do we know how to do this for November?

1.5.5.3.1. Yes, we have enough to write the baseline. The Editor will proceed.

1.5.5.4. No objections.

1.5.6. BSS Overlap

1.5.6.1. Proposed terminology –

1.5.6.1.1. visible BSS overlap (VBO) – APs can hear each other.

1.5.6.1.2. hidden BSS overlap (HBO) – the overlap is invisible to the APs but coverage areas overlap

1.5.6.1.3. indirect BSS overlap (IBO) – no overlap, but there are stations in the interference range, but not the communication range.

1.5.6.2. What is different between the indirect and the hidden?

1.5.6.2.1. With hidden, stations can act as relays.

1.5.6.3. These cases will be given names in the baseline.

1.5.6.4. What do we want to include in the baseline?

1.5.6.5. What are the open issues?

1.5.6.5.1. Primarily differing opinions on the degree to which this is a problem.

1.5.6.5.2. In 1993, this was concluded as being unsolvable. It would be easier to solve if PCF was the only mechanism.

1.5.6.5.3. How much complexity is it worth putting in to mitigate this problem?

1.5.6.6. The relay function helps the APs avoid each other in both PCF and DCF.

1.5.6.7. Are we better off having an interim solution in Tampa, or just referring back to the former presentations? There is a lot of text to write in 1½ weeks.

1.5.6.8. Proposals with solutions:

1.5.6.8.1. Joint Proposal - Wim

1.5.6.8.2. Philips - Sunghyun

1.5.6.8.3. Sharp - John

1.5.6.9. Do we need a mini-editing team to work on this?

1.5.6.9.1. A good idea, but still has to be coordinated closely with the editor for frame formats.

1.5.6.9.2. Wim, John, Sunghyun to work on this.

1.5.6.9.3. Harry also offers a contributor from AT&T to help.

1.5.6.9.4. They will work on text for clause 9.

1.5.6.10. The team will provide output to Michael by next week.

1.5.7. Logistics – Next weeks teleconference

1.5.7.1. Next weeks teleconference will be a good time to review the draft text.

1.5.7.2. The draft should only be distributed to those that are here at this meeting.

1.5.7.3. If we distribute the draft to the whole reflector, it will be better to wait till Tampa.

1.5.7.4. This group here today will review the draft, review at next weeks teleconference. Then we will distribute to the whole reflector.

1.5.7.5. We will not adjourn this meeting, but recess until next week's teleconference.

1.5.7.6. Motion to extend the time to adjourn this ad-hoc meeting until next Wednesday, November 1, after the teleconference.

1.5.7.6.1. Accepted with No Objections

1.5.8. Action Items

1.5.8.1. Wim and the BSS Overlap Editing Group will provide text for section 9 to Michael by Monday.

1.5.8.2. This will definitely not include any IAPP mechanisms.

1.5.9. Open issues - Editor

1.5.9.1. MLME_WMstatus request/confirm. What are the useful parameters? This is used by an external entity to make decision on available bandwidth. We can't leave this blank.

1.5.9.2. We need a plausible list of what they are.

1.5.9.2.1. Vector of CW's for the DCF

1.5.9.2.2. Measured load per category (in what interval)

1.5.9.2.3. PHY type

1.5.9.3. Between now and Friday, we need to take input on this.

1.5.9.4. We need assistance to inspect the IETF documents to insure we can accommodate SBM with a simple but sufficient set of parameters.

1.5.9.5. Menzo and Keith will work on this.

1.5.9.6.

1.6. Conclusion

1.6.1. Actions

1.6.1.1. Teleconference next Wednesday. Harry to distribute to the list of attendees at this meeting.

1.6.1.2. Michael to distribute draft baseline on Monday

1.6.2. Recess until teleconference

EXHIBIT D

IEEE P802.11
Wireless LANs

Minutes of 802.11 Task Group E
MAC Enhancements

Date: November 6, 2000

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Minutes of the IEEE P802.11 Task Group E MAC Enhancements

November 6 - 10, 2000

Hyatt Regency Tampa, Tampa, FL

1. Monday Afternoon

1.1. Secretary

1.1.1. Tim Godfrey

1.2. Call to order

1.2.1. 3:30 PM

1.3. Poll of new participants

1.3.1. First time at TGe (about 40)

1.4. Agenda

1.4.1. Proposed Agenda (for Joint activities of two subgroups)

1.4.1.1. Approval of Minutes
1.4.1.2. Overview of 802.11 policies
1.4.1.3. Voting Rights, debates, key motions
1.4.1.4. Schedule
1.4.1.5. Organization
1.4.1.6. Question on document 066
1.4.1.7. Call for papers
1.4.1.8. Recess for SubGroups
1.4.1.9. Presentation of papers

1.4.1.10. New Business

1.4.1.11. Next meeting agenda

1.4.1.12. Presentation to WG Plenary

1.4.2. Overall Objective

1.4.2.1. Develop initial draft

1.4.3. Discussion on Agenda

1.4.3.1. None

1.4.4. Adoption of Agenda

1.4.4.1. No Objection, adopted by unanimous consent.

1.5. Approval of the Minutes

1.5.1. Discussion

1.5.1.1. None

1.5.2. Minutes approved without objection

1.6. Policy Overview

1.6.1. Attendance book, voting rights

1.6.2. Voting rights in Ad Hoc groups are at the discretion of the chair

1.6.3. Debates – only voting members, but at the chairs discretion others may participate.

1.6.4. Key Motions

1.7. Schedule Overview

1.7.1. This group has been operating for about a year. The original goal was to have a WG ballot at the end of this meeting. We may be close. There is a lot of convergence towards a baseline, in both QoS and Security.

1.7.2. Next step is a draft for Working Group Ballot.

1.7.3. This group (TGe) will address the comments

1.7.4. The objective is to get 75% approval of WG members, but the unwritten rule is to get consensus in the 90% range before submitting for sponsor ballot.

1.7.5. Assuming we start the balloting process at end of this week, or the latest January 2001, we are on a good path.

1.7.6. Discussion / Question

1.7.6.1.

1.8. Organization of TGe

1.8.1. We divided the work into QoS and Security in September.

1.8.2. The TGe Editor is Michael Fischer

1.8.3. Sub Editors

1.8.3.1. Jesse Walker (Security)

1.8.3.2. Michael Fischer (QoS)

1.8.4. QoS and Security operate in parallel due to schedule constraints.

1.8.5. Report on QoS – John F

1.8.5.1. We have started drafting the sections. We have a solid proposal on PCF, and DCF is rapidly coming together, and there is consensus.

1.8.5.2. We have made the formal announcement that this week is the last opportunity for papers and proposal to be incorporated in the sponsor ballot.

1.8.5.3. Discussion

1.8.5.3.1. Will there be a full session for the vote?

1.8.5.3.2. This will be done in a Full TGe session.

1.8.5.3.3. TGe will consider the baseline after the Ad Hoc finished.

1.8.5.3.4. Wednesday AM, the QoS Ad Hoc group could present a motion to the full TGe session

1.8.6. Report on Security – Dave H

1.8.6.1. A number of proposals were reviewed at the last meeting.

1.8.6.2. Working on merging them now.

1.8.6.3. Consideration of whether RC4 is adequate, or if something else is needed

1.8.6.4. Looking at the merged proposals.

1.8.6.5. The group is still in the Ad Hoc group, but the QoS group may be a little ahead. If the baseline is not ready by the end of the week, there will be another meeting scheduled before the January meeting.

1.8.7. Editorial

1.8.7.1. Jesse and Michael to get together and work on draft integration.

1.8.7.2. Substitute Editor for Wednesday and Thursday (when Michael has to leave).

1.8.7.2.1. To be decided between Tom T, Anil K, and Simon B.

1.8.7.3. The editor is also cleaning up inconsistencies and errors in the existing MAC clauses. A list of such issues will be developed after this meeting.

1.8.7.3.1. If anyone is aware of clarification issues or problems in the existing standard, please direct it to Michael's attention.

1.8.8. Appointment of Vice Chair

1.8.8.1. This is getting to be a significant task, with lots of parallel activities and between meeting activities. It is too much for John as the Chair.

1.8.8.2. Is there any objection to appoint a vice chair to assist TGe?

1.8.8.2.1. No Objections

1.8.8.3. There is one volunteer – Duncan Kitchin.

1.8.8.4. Any other nominations?

1.8.8.4.1. None

1.8.8.5. Duncan Kitchin accepted as Vice Chair by acclamation.

1.8.9. Review of Document 066 questions on requirements?

1.8.9.1. There are no outstanding objections or issues with anyone in the group.

1.8.10. Call for Papers (for presentation to Joint TGe group)

1.8.10.1. Michael Fischer, document 337, "Generic Management Actions"

1.8.10.2. Duncan K Document ??? "A Network Enrollment Protocol"

1.8.11. Call for Papers (For QoS)

1.8.11.1. Jin Meng Ho, paper 363, "Graphic Description of 802.11E Performance.

1.8.11.2. Jin Meng Ho, paper 367 P-DCF

1.8.11.3. John Kowalski, document 377 "FEC Frame Formats for 802.11a"

1.8.11.4. document 383 "A consideration on FEC"

1.8.11.5. Michael Fischer document 358 and 360 "QoS Ad Hoc Baseline Proposal"

1.8.11.6. Document 336 "PIFS Ambiguity"

1.8.11.7. Wim D Document 398 "Baseline DQos Proposal"

1.8.11.8. Duncan Document ??? "FEC for QoS "

1.8.11.9. doc 387 "Scheduling for level 2 enhanced PCF"

1.8.11.10. Doc 375 "Tiered contention"

1.8.11.11.

1.8.12. Call for Papers (Security)

1.8.12.1. Bob Beach Doc 381 "Security Eval Criteria

1.8.12.2. Doc 382 "Joint Proposal for 802.11 Security"

1.8.12.3. Jesse Walker Doc 362 " WEP Analysis"

1.8.12.4. doc 376 "SAIN"

1.8.13. Other papers (no presentation)

1.8.13.1. Doc 370 "Minutes of Interim Teleconference"

1.8.13.2. Doc 368 "Mediaplex enhanced proposal for QoS driven wireless LANs"

1.9. Presentation of Papers

1.9.1. Document 337, Michael Fischer

1.9.1.1. "Generic Management Action"

1.9.1.2. Overview

1.9.1.2.1. There are a number of parallel activities that will need to have management information exchanges over the wireless medium

1.9.1.2.2. We are low on frame types, so this mechanism helps save codes.

1.9.1.2.3. This mechanism is in the QoS Baseline Proposal and only needs to be there once.

1.9.1.2.4. Categories can be assigned to sub groups like QoS and Security to allow parallel development with less required coordination.

1.9.1.3. Discussion

1.9.1.3.1. Does this intend to move away from the restriction of fixed fields word aligned headers? No, the field is a single 4 octet field.

1.9.2. Document 377, John Kowalski

1.9.2.1. "FEC Frame Formats"

1.9.2.2. Overview

1.9.2.2.1. From review of AV requirements of 802.11

1.9.2.2.2. Timing issues with adding FEC Coding to 802.11

1.9.2.2.3. The general requirement is an error rate of 1E-9 with minimal overhead.

1.9.2.2.4. Compatible with OFDM symbol sizes

1.9.2.2.5. Is this a MAC or PHY issue? The PHY would be a nice place – you could protect the PLCP header. However it would need a new PAR.

1.9.2.2.6. 802.11a timing (table 93) issues. In particular, an entire frame must be decoded and acked within a SIFS time.

1.9.2.2.7. It was not possible to demonstrated that this could be done with today's technology.

1.9.2.2.8. However there is a proposal for a delayed ACK in the proposal.

1.9.2.2.9. There are many coding schemes that meet the requirements.

1.9.2.2.10. AV formats are in multiples of 48 bytes.

1.9.2.3. Discussion

1.9.2.3.1. Aren't error mechanisms chosen for the types of expected errors? So they should correspond to 802.11a specific errors? And thus it would be 802.11a specific?

1.9.2.3.2. We are attempting to make changes to the 802.11a PHY for SMA in Europe. So there will be corresponding changes to the MAC.

1.9.2.3.3. RS codes do not stop at 255.

1.9.2.3.4. Why is there an FCS in the field? Isn't the FEC a better error check. If this code can correct these errors, it will exceed the hamming distance requirements.

1.9.2.3.5. How do you distinguish the different MPDU formats from the normal?

1.9.2.3.6. Regarding the interaction between security and QoS. How do we sort out whether the FEC protects the security, or vice versa? We need to figure this out as we go…

1.9.2.3.7. What error rate does the existing system offer? What is the undetected error rate? Very low due to ACKs. But if you want to maintain a small number of retries, then the existing system is insufficient.

1.9.2.3.8. In the existing standard the retry limit parameter allows control of latencies.

1.9.2.3.9. There was a proposal for sending MPDU fragments 5 times, and any 3 are enough to use it.

1.9.2.3.10. We cannot guarantee perfection, but we want to increase the envelope of what is workable.

1.9.3. document 383 "A consideration on FEC"

1.9.3.1. Matsushita

1.9.3.2. Overview

1.9.3.2.1. FEC is used in digital cable, satellite, etc

1.9.3.2.2. Concatenation of Viterbi and Reed Solomon codes.

1.9.3.2.3. The Viterbi Code in the 802.11a PHY and an FEC option in 802.11E provide an improvement.

1.9.3.3. Discussion

1.9.3.3.1. What does the implementation look like? There are four RS blocks interleaved.

1.9.3.3.2. Does the interleaver need to change with the PHY rate? No

1.9.3.3.3. The interleaver works reasonably well for 16QAM with rate ¾.

1.9.4. Recess for Ad Hoc Sub Groups

2. Monday Evening TGe QoS SubGroup

2.1. Called to Order at 6:30PM

2.2. Agenda

2.2.1. Proposed Agenda

2.2.1.1. Overview of activities

2.2.1.2. Recess for Ad-Hoc

2.2.1.3. Papers (Ad Hoc)

2.2.1.4. Draft Editing (Ad Hoc)

2.2.1.5. Adjourn Ad Hoc

2.2.1.6. Reconvene TGe QoS SubGroup

2.2.1.7. Draft Approval

2.2.1.8. Motions for TGe

2.2.1.9. Adjourn SubGroup

2.2.2. Discussion on Agenda

2.2.2.1. Does the Ad Hoc status give the submitted papers full 802.11 submission status?

2.2.2.2. Anything submitted is an official submission

2.2.3. Adoption of Agenda

2.2.3.1. Adopted without objection

2.3. Overview of Activities

2.3.1. Discussion

2.3.1.1. We will start by reviewing the baseline, and then any new papers to see how and if they can be integrated into the baseline.

2.3.1.2. The goal is to have an initial draft completed.

2.3.1.3. By Wednesday, we can decide what to do with the draft. We can consider whether it is ready to ballot, or determine a work plan between now and January to have it ready for ballot.

2.3.1.4. When do we present the papers? During the Ad Hoc.

2.3.2. Any Objection to recess for Ad Hoc

2.3.2.1. No Objections

2.4. Ad Hoc QoS Group

2.4.1. Presentation of Papers – Document 358, Michael Fischer

2.4.1.1. "Summary of the QoS Baseline Proposal"

2.4.1.2. Overview

2.4.1.2.1. Developed during the month of October during teleconferences and the New Jersey meeting.

2.4.1.2.2. The primary output documents are document 360r0. There will be an r1 with more clauses in the morning.

2.4.1.2.3. Clause 9 will need to be worked on this week.

2.4.1.2.4. Document 358 is a presentation of the document 360.

2.4.1.2.5. Why adopt a baseline?

2.4.1.2.5.1. To have a framework to evaluate proposals

2.4.1.2.5.2. To focus effort on areas that are incompletely defined

2.4.1.2.5.3. To move quickly to a draft for initial letter ballot.

2.4.1.2.6. Features of Baseline

2.4.1.2.6.1. Upward compatible and coexistent with 802.11-1999

2.4.1.2.6.2. Supports both prioritized and parameterized QoS

2.4.1.2.6.3. Provides QoS delivery under EDCF and EPCF

2.4.1.2.6.4. BSS overlap mitigation

2.4.1.2.6.5. New structural elements to extend BSS coverage and connectivity.

2.4.1.2.7. Conformance Levels

2.4.1.2.7.1. Conformance levels are attributes of the association.

2.4.1.2.7.2. Levels vary by style of QoS (prioritized and parameterized) and Coordination functions.

2.4.1.2.8. MAC SAP

2.4.1.2.8.1. No changes to service primitives

2.4.1.2.8.2. Priority parameter used to identify traffic category. (0-7)

2.4.1.2.8.3. With the existing standard, this field indicates delivery modality.

2.4.1.2.8.4. The interface is uniform across all conformance levels.

2.4.1.2.9. Enhanced Station Model

2.4.1.2.9.1. At least 4 Queues below MAC sap.

2.4.1.2.9.2. There is a conceptual scheduler below the queues to select the next TXop.

2.4.1.2.9.3. The channel access function (EDCF or EDCF) is independent of the scheduler.

2.4.1.2.10. Traffic Categories

2.4.1.2.10.1. Global per QBSS, as priorities for prioritized levels.

2.4.1.2.10.2. Level 0 is not the lowest priority in 802.1h. (It may make sense to order the priorities as 1, 2, 0, 3, 4, 5, 6, 7) where 0 is best effort.

2.4.1.2.11. Functional Improvements

2.4.1.2.11.1. Allowance of direct ESTA-ESTA transfers

2.4.1.2.11.2. Directed probe request to learn capabilities.
2.4.1.2.11.3. Improved Beacon reliability
2.4.1.2.11.4. Allow RTS/CTS during CFP
2.4.1.2.11.5. CF-Polls convey TxOps
2.4.1.2.11.6. Clarify ambiguous provisions in clause 9.

2.4.1.2.12. New Mechanisms

2.4.1.2.12.1. Transmit Opportunities
2.4.1.2.12.2. Traffic Category Identifiers
2.4.1.2.12.3. Aggregation
2.4.1.2.12.4. Burst Transfers
2.4.1.2.12.5. Delayed Acknowledgement
2.4.1.2.12.6. Centralized Contention and Reservation Request
2.4.1.2.12.7. Alternate EAP / EPC
2.4.1.2.12.8. BSS overlap mitigation
2.4.1.2.12.9. Bridge Portals

2.4.1.2.13. Enhanced DCF

2.4.1.2.14. Enhanced PCF (based on Joint Proposal)

2.4.1.2.14.1. Does not used BSS Unique VSID's nor external classifier entities.

2.4.1.2.15. MLME SAP

2.4.1.2.15.1. TSupdate to define and modify traffic specifications
2.4.1.2.15.2. Sense the state of the wireless medium.

2.4.1.2.16. Aggregation

2.4.1.2.16.1. New container frame is defined

2.4.1.2.17. Power Save

2.4.1.2.17.1. Basically in conflict with QoS. Today Power Save has priority, but QoS must be maintained in QBSS.
2.4.1.2.17.2. Listen Epoch – portions of beacon interval a station must be awake to listen.

2.4.1.2.18. Incomplete items and placeholders

2.4.1.2.18.1. FEC
2.4.1.2.18.2. EDCF access mechanism
2.4.1.2.18.3. BSS overlap mitigation
2.4.1.2.18.4. Bridge Portals
2.4.1.2.18.5. Interaction with Higher Layer end-end management entities (informative annex describing a recommended practice)

2.4.1.3. Discussion

2.4.1.3.1. Is overlap mitigation possible under 802.11E?

2.4.1.3.2. Yes, only and 802.11E AP will have the proper support and understand the necessary elements.

2.4.1.3.3. Are BSS overlap and DFS solving the same problem?

2.4.1.3.4. If you have DFS, it is far superior to move the BSS to another channel than to share the time on the air. True frequency planning is always better, but we need to support the 3 channel 2.4GHz band, and un-coordinated situations like multi-family homes.

2.4.1.3.5. Are the proxy beacons used for the mitigation algorithm, or do they affect APs in adjacent BSS's?

2.4.1.3.6. In the mitigation mode, they cause the CFPs to be offset in time. It also identifies stations in the overlap region and their frame loss rate.

2.4.1.3.7. A legacy station would set its NAV from a proxy beacon.

2.4.1.3.8. The intent of the proxy beacon in a QBSS is to set timing, not to set ESTA NAVs. This is under our control.

2.4.2. Areas needing more discussion in the baseline proposal

2.4.2.1. DCF part of baseline

2.4.2.2. Guaranteed Beacon

2.4.2.2.1. Fragmentation?

2.4.2.3. power save mechanism

2.4.2.4. Direct Probes

2.4.2.5. parameters that need to communicate to higher layers.

2.4.3. Call for papers

2.4.3.1. None currently available

2.4.4. Discussion of baseline issues

2.4.4.1. We cannot discuss DCF until presentations

2.4.4.2. Burst length – is there a limit to the burst length? Yes, the TxOp length, which is the same as the MAX MPDU of 2304 octets. The intent is to remove PHY overhead for short packets.

2.4.4.3. Power Save Mechanism

2.4.4.3.1. More background is needed for what happened between Joint Proposal and baseline Power Save

2.4.4.3.2. In legacy 802.11 it is easy since all traffic goes through AP. The challenge is when the source and dest are in the BSS and could use direct STA-STA. The AP has to schedule the TXoP, but also the Listen Epoch.

2.4.4.3.3. In the Joint proposal all stations know the streams, now we only have traffic category. The Listen Epoch from Joint proposal don't apply anymore.

2.4.4.3.4. Conclusions from New Jersey Ad Hoc –

2.4.4.3.4.1. Listen Epoch can work at Level 3.

2.4.4.3.4.2. Listen Epoch can be used via AP at any level (like today).

2.4.4.3.4.3. DCF – like today.

2.4.4.3.4.4. At any level below 3, you send PS traffic via the AP. The AP would send directly following the beacon.

2.4.4.3.4.5. Direct STA-STA could work at level 3.

2.4.4.3.5. Definition of PS non-poll :

2.4.4.3.5.1. The way PS is defined today is based on the DTIM – stay awake if your bit is on, until you recv a frame with the MoreData bit is 0, or CFend

2.4.4.3.5.2. The concept of "stay awake until you get your traffic" may be not much better than no power save at all.

2.4.4.3.5.3. Document 360, clause 7 defines this.

2.4.4.3.6. There were a number of people who want power save, but they have no opinion of what it should be. This seems to meet those criteria.

2.4.4.3.7. It is not seen as very useful to do IBSS power save. The new dynamic AP capability makes the IBSS "obsolete". This should wait until we have a stable DCF QoS mechanism.

2.4.4.4. Discussion of rigid limit at TBTT

2.4.4.4.1. Like there is a hard rule for the FH PHY that a transmission cannot extend across a dwell boundary into a hop time, we can make a rule that an 802.11E conformant devices will not be allowed to transmit across a TBTT (beacon transmission time).

2.4.4.4.2.

2.4.5. Presentation of Paper – document 336

2.4.5.1. Michael Fischer

2.4.5.2. "the PIFS ambiguity"

2.4.5.3. Overview

2.4.5.3.1. Practical limitations on the use of PIFS

2.4.5.3.2. PIFS is supposed to be a priority interframe space.

2.4.5.3.3. Two uses:

2.4.5.3.3.1. To provide the AP with priority access in the contention free period

2.4.5.3.3.2. To allow the PC to retain control of the medium in the case of non-response.

2.4.5.3.4. Some proposals have suggested to expand the use of PIFS, but it is not really useful.

2.4.5.3.5. There are two issues:

2.4.5.3.5.1. SIFS PIFS ambiguity – the PC may transmit another frame.

2.4.5.3.5.2. The absence of CCA busy at PIFS is not a good indication that nothing happened. Antennas may be sampled once per slot.

2.4.5.3.5.3. To mitigate – only use PHYs with PHYs that have fast CCA and check all antennas in a slot time.

2.4.5.3.5.4. PIFS – DIFS ambiguity

2.4.5.3.5.5. There is only one CCA measurement, so CCA idle after PIFS doesn't guarantee a clear

channel. A collision is possible if a station's backoff is a 1

2.4.5.4. Discussion

2.4.5.4.1. The issue is really the accuracy and timing of CCA.

2.4.5.4.2. Conclusion – PIFS is not a panacea – there is still a probability of a collision, just as in any DCF contention.

2.4.6. Recess until tomorrow

3. Tuesday Morning TGe QoS Session

3.1. Introduction

3.1.1. Plan for today

3.1.1.1. Cover papers this morning – presentation without debate

3.1.1.2. This afternoon, start with baseline establishment

3.1.1.3. We will have straw polls to gauge our progress on baseline acceptance

3.1.1.4. Once we have strong consensus, we will have a formal meeting to vote acceptance

3.1.1.5. During straw polls, "no" votes and abstainers must explain what issues are keeping them from a "yes" vote.

3.1.2. Call for Papers

3.1.2.1. Jin Meng Ho, paper 363, "Graphic Description of 802.11E Performance. (30 min)

3.1.2.2. Jin Meng Ho, paper 367 P-DCF (30 min)

3.1.2.3. document 383 "A consideration on FEC"

3.1.2.4. Wim D Document 399 "Baseline DQos Proposal" (1 hour)

3.1.2.5. Duncan Document ??? "FEC for QoS " (15 minutes)

3.1.2.6. Wen Ping Ying, doc 387 "Scheduling for level 2 enhanced PCF"

3.1.2.7. Matilde Benvenista. Doc 375 "Tiered contention"

3.2. Presentation of Papers

3.2.1. "A scheduling scheme for Level 2 enhanced PCF MAC Service

3.2.1.1. Doc 387, Wen Ping Ying, Nextcomm Inc

3.2.1.2. Overview

3.2.1.2.1. Based on Wim's Baseline to be presented later

3.2.1.2.2. To go through the bridging between level 1 and level 3 QoS.

3.2.1.2.3. Operation of level 2 PCF model

3.2.1.2.4. Intention is that same scheduling mechanism can be used in level 1 and level 2

3.2.1.2.5. Random number aspect of VDCF is used for scheduling mechanism to rank/order/prioritize frames for transmission during the CFP

3.2.1.2.6. CW vector from AP may be adopted by STA

3.2.1.3. Discussion

3.2.1.3.1. Why do you believe that level 0 PCF is fair? It depends on the Access Point. Fairness is not standardized.

3.2.1.3.2. Why you believe it is necessary to standardize the order the PC does things? Agrees that it is up to the implementation.

3.2.1.3.3. There was a suggestion that it was in address order.

3.2.1.3.4. Are there any other changes other than dropping all the advanced capabilities of Level 2? No

3.2.1.3.5. There was a suggestion that the scheduling mechanism was the same as VDCF. Aren't there cases where come queues would never get scheduled?

3.2.2. "Baseline D-QoS Proposal"

3.2.2.1. Document 399, Wim Diepstraten

3.2.2.2. Overview

3.2.2.2.1. Part of total layered QoS proposal

3.2.2.2.2. Enhanced DCF used in levels 1, 2, and 3

3.2.2.2.3. The class differentiation is only active when there is an active traffic load in higher priority classes.

3.2.2.2.4. Load feedback (monitoring and measurement) per priority class is needed.

3.2.2.2.5. Service rate control, and drop rate control regulate the offered load

3.2.2.2.6. Medium monitoring provides load per class in terms of CoX (contention offset) and CWx (contention window)

3.2.2.2.7. Contention offset allows more differentiation control (added after simulation work started on DQoS)

3.2.2.2.8. Retry mechanism – to temporarily reduce the load for stability reasons. .

3.2.2.3. Simulation Results – Greg Chesson

3.2.2.3.1. Limited scope environment in NS simulator.

3.2.2.3.2. Model 1 – simple uniform traffic, 4 access classes. Goal – observe differentiated service

3.2.2.3.3. Model 2 – 4 phones (higher access class) plus 8 tcp/ip streams (lower access class)

3.2.2.3.4. Common scenarios are needed between NS and OpNet environments.

3.2.2.3.5. Model 1 results show that there is differentiation of bit rate and latency/jitter from the classes.

3.2.2.4. Discussion

3.2.2.4.1. Load measurement and translation are up to the implementer? Yes, medium occupancy time should be the measure. The load monitor is put in the same category as the scheduler in level 3

3.2.2.4.2. Where is the burst/aggregation mechanism? Burst should be implemented in level 1. The baseline does not limit aggregation to any level. It is just a new frame type, usable anywhere.

3.2.2.4.3. What about re-ordering frames within a queue if a destination doesn't respond? That is in the proposal as a non-exhaustive retry provision, within a priority.

3.2.2.4.4. It seems that the only way this works if it is not loaded too much, so there must be a higher layer managing the load. Would it degrade so that there will be no service to any?

3.2.2.4.5. the DQOS proposal doesn't address all the QoS requirements. Which requirements does this attempt to address? This hasn't been done yet – but believe it to be good enough for many things.

3.2.2.4.6. These simulations show some differentiation. There are two mechanisms the scheduler and channel access mechanism. How much value is attributed to the differentiated queues vs channel access? The channel access is the primary effect. The mechanism is proposed to be used twice, but the simulations use it once. Using it twice will help with collisions on the medium.

3.2.2.4.7. Has enough attention been paid to the accidental overload condition?. The overload has been driven, and the problem comes from too many stations, not too much traffic. There are things that can be done to handle the overload case.

3.2.2.4.8. Could the contention free bursts be enhanced to give some of the features of PCF? Suggestion that the questioner write it up as a submission.

3.2.2.4.9. We need to distinguish between handling the offered load vs presenting the load in the first place. In some cases the offered load must be controlled.

3.2.3. "Tiered Contention, A QoS-Based Distribution MAC Protocol"

3.2.3.1. Document 375, Mathilde Benveniste, AT&T

3.2.3.2. Overview

3.2.3.2.1. Urgency classes – change arbitration time based on urgency.

3.2.3.2.2. The time the channel must be sensed idle changes with urgency.

3.2.3.2.3. In terms of slot time.

3.2.3.2.4. Congestion-adaptive, traffic-specific backoff

3.2.3.2.5. Collision resolution with collision avoidance.

3.2.3.3. Discussion

3.2.3.3.1. How often is the backoff counter computed? When the channel is idle for an arbitration time, the counter is decremented.

3.2.3.3.2. There is not infinite granularity of timing. The slots are there because of propagation delays. The solution is that you can avoid a finite set of countable values. But it might not be worth the effort for the small gain.

3.2.3.3.3. It will only result in the starvation of lower classes if there is no way to change the classification in the buffer.

3.2.3.3.4. What prevents a collision here if you don't synchronize the start of the countdowns? You could select the D and H variables properly.

3.2.3.3.5. If the start of the countdown isn't synchronized between stations, how does it work? You have to have

prior synchronization, but not packet by packet synchronization.

3.2.4. p-DCF scheme for prioritized services

3.2.4.1. Document 367, Jin Meng Ho

3.2.4.2. Overview

3.2.4.2.1. Probabilistic vs Backoff access

3.2.4.2.2. Proposal for pure probabilistic DCF access

3.2.4.2.3. Simulations underway

3.2.4.3. Discussion

3.2.4.3.1. There is no relevance of TxOp vs RxOp. The job of a MAC is TxOp control. But if it was, how would this be different in controlling RxOps? The difference is in resolving local collision. In this scheme no local collisions would occur. In VCDF all dcf's would have to back off. (But neither addresses the question 1 of RXop) agreed...

3.2.4.3.2. Have you looked at the jitter involved? The access time is geometrically distributed – which has a nice std dev probability.

3.2.4.3.3. Have you looked at the collision probabilities between the approaches? We have minimized collision probability by the estimation.

3.2.4.3.4. The VDCF is intrinsically fair, but it is possible to introduce unfairness if needed for special flows.

3.2.4.3.5. If we have a mixed BSS mixing this proposal with the existing DCF, how will this work? Yes, the existing NAV and RTS/CTS rules are retained.

3.2.4.3.6. In all the DCF proposals with backoff you increase the contention window after a failure. It seems that this proposal reduces the window? The reduction is in the contention probability, which is analogous to increasing the contention window.

3.2.4.3.7. Is there a mechanism for post backoff after a successful transmission? Yes, you reset the probability for that category.

3.2.5. Traffic Descriptions for 802.11 performance simulation

3.2.5.1.1. Document 363, Jin Meng Ho

3.2.5.1.2. Overview

3.2.5.1.2.1. Common simulation scenario for evaluation of 802.11e QoS MAC scenarios.

3.2.5.1.2.2. Multiple traffic sources.

3.2.5.1.2.3. Traffic sources are described with quantitative descriptions.

3.2.5.1.2.4. Delay and variation are considered.

3.2.5.1.3. Discussion

3.2.5.1.3.1. How realistic is these distribution? The are not real life, but capture major features of applications.

4. Tuesday Afternoon TGe QoS Session

4.1. Baseline Polling

4.1.1. Procedure Objective

4.1.1.1. Approve a baseline by the end of today or tomorrow.

4.1.1.2. Take several straw polls

4.1.1.3. If we have strong consensus >80% then we will take the baseline to a formal meeting, where we can get it accepted.

4.1.1.4. If anyone says no during a straw poll, they need to explain why, and what could be done to change their vote to yes.

4.1.1.5. The baseline can have "black boxes" at this point. Don't vote no because of missing detail, as long as the baseline allows for the concept to be discussed at a later time.

4.1.2. Discussion

4.1.2.1. Are non-voters allowed to participate in straw polls? Yes

4.1.2.2. Perhaps we should have two straw polls, so non voters don't make us think the wrong thing about the voters.

4.1.3. Are there any clarifications that are needed at this point on the baseline?

4.1.3.1. The different levels of QoS, how do they affect implementation? A device must support all lower levels.

4.1.3.2. What does 802.11E compliance mean then? What level? We have not resolved this yet. It was not critical to the baseline. This is a labeling issue.

4.1.3.3. A conformance group in the 802.11E PICS will be mandatory for 802.1E level 1, and another for group 1 or 2, and a group for 1 or 2 or 3.

4.1.3.4. Wouldn't this be the same compliance rule as the existing DCF / PCF in the standard? Yes, so is WEP.

4.1.3.5. Can we make suggestions for broadening certain specifications? Specifically the specification for scheduling and access of Wim and Michaels presentation.

4.1.3.6. It is better to decide a specific approach, people will start implementing, and it is more difficult to change later.

4.1.3.7. The VDCF is not a scheduler. We are getting confused over a scheduler. No one is proposing we standardize a scheduler. Lets move on.

4.1.3.8. Lets leave the access approach and the scheduler approach as a "black box"

4.1.3.9. Once we adopt a baseline, it will take 75% to change it. So making changes will be difficult. Lets not put something in and expect it will be easy to take it out.

4.1.3.10. It is easier to take things out than to add later (due to internal consistency issues)

4.1.3.11. What about fragmentation? Is something like that in the baseline? What you use it for is not specified. The plan is to remove the restriction on size and scheduling gaps.

4.1.3.12. What is our methodology to approve the baseline? Can we agree on the things we have broad consensus on? We will have a straw poll after these questions. We will record issues, and then address them.

4.1.3.13. In the nested architecture, the level 3 EAP shall support level 1? Yes

4.1.3.14.

4.1.4. Straw Poll

4.1.4.1. There are 39 Voting Members present

4.1.4.2. How many disapprove the baseline as presented?

4.1.4.2.1. Tom

4.1.4.2.2. Anil

4.1.4.2.3. Matthew

4.1.4.2.4. Bob

4.1.4.2.5. Raju

4.1.4.2.6. Sid

4.1.4.2.7. Jin Meng

4.1.4.2.8. Harry

4.1.4.2.9. Sunhyun

4.1.4.2.10. Matthew S

4.1.4.2.11. John Coffey

4.1.4.3. How many abstain?

4.1.4.3.1. Ca-Che

4.1.4.3.2. Wen-Ping

4.1.4.4. How many approve - 24

4.1.4.5. Current count 24:11:2

4.1.5. Straw Poll of Non-voters

4.1.5.1. Approve of baseline - 7

4.1.5.2. Disapprove of the baseline – 3

4.1.5.2.1. Brian

4.1.5.2.2. Khaled

4.1.5.2.3. Liwen

4.1.5.3. Abstain - 6

4.1.6. Resolution of Issues with Baseline

4.1.6.1. Raju

4.1.6.1.1. Eliminate QoS Null sub-types

4.1.6.1.2. Table 3 – data subtypes –0000 compatibility issue

4.1.6.1.3. Clause 7.2.1.1 – RTS / CTS

4.1.6.1.4. Clause 7.2.1.10- Feedback with AID or ESTA address

4.1.6.1.5. Clause 7.2.1.13 – TxOp Flags from joint proposal are absent. Record count =0 to cancel schedule.

4.1.6.1.6. Wants an advanced power management category

4.1.6.1.7. Clause 7.2.3.13 – references to superframe and TBTT

4.1.6.1.8. Duncan – need categorization of these points into show-stoppers and editorial.

4.1.6.1.9.

4.1.6.2. Anil

4.1.6.2.1. Why all the complexity in level 3 is there? We started with the most complex MAC ever, and this adds an order of magnitude of complexity. Do we need that complexity? Would like to drop Level 3

4.1.6.2.2. Persistent Polls – similar to TDMA. Has this been justified? Feels that it is complex to implement.

4.1.6.2.3. Aggregation – for the set of transactions it is used it, is it worth the effort.

4.1.6.2.4. Delayed acknowledgement – this is a can of worms. Very high level protocol don't implement them.

4.1.6.2.5.

4.1.6.3. Sid

4.1.6.3.1. It is premature to select a DCF access method.

4.1.6.3.2. We need more simulation results for enhanced DCF

4.1.6.3.3. We need one meeting period to find the best out of the three.

4.1.6.3.4. Would vote yes if we "black box" the DCF access method.

4.1.6.4. Harry, Bob, and Matt S

4.1.6.4.1. Agrees with black box concept for DCF

4.1.6.4.2. Doesn't care for nesting procedure – it could be better done with levels 1.5 and 2, merging 1 and 2 existing levels. It would have to include cf-pollable capabilities.

4.1.6.5. Tom

4.1.6.5.1. Related to Nesting – disagree with options within an option. All levels should be mandatory within 802.11E.

4.1.6.6. Sungyhun

4.1.6.6.1. too early to decide on DCF channel access

4.1.6.6.2. BSS overlap mitigation, but wants more details.

4.1.6.7. Jin Meng

4.1.6.7.1. Black Box the DCF and scheduler

4.1.6.8. Brian

4.1.6.8.1. wants more text on the baseline. Would change to Yes if the No voters now would change to Yes.

4.1.6.9. Wen-Ping

4.1.6.9.1. looking from the implementation, Level 0 is already there. Suggests to use the same level 0 frames for PCF and level 2 in PCF.

4.1.6.9.2. Either take out mandatory use of RR and CC or make it optional in Level 2.

4.1.6.9.3.

4.1.7. Non Voter's issues with baseline

4.1.7.1. Mathildhe

4.1.7.1.1. Covered by previous issues (black box for DCF access)

4.1.7.2. Khaled

4.1.7.2.1. the group should agree on one simulation framework in order to compare results. Therefore there has to be consensus on simulation.

4.1.7.3. Liwen

4.1.7.3.1. DCF black box

4.1.7.4. Adrian Stephens

4.1.7.4.1. The biggest concern is the number of things in a hardware implementation.

4.1.7.4.2.

4.1.7.5. John K changes yes to abstain over DCF channel access (concern over useful QoS in DCF)

4.1.7.6. Bob Mier

4.1.7.6.1. Concern over proxy beacon mechanism and OBSS mechanism

4.1.7.7.

4.1.8. Discussion

4.1.8.1. How will we deal with these concerns? We are still Ad Hoc, so we don't need motions.

4.1.8.2. Now, we will address areas that are non-controversial.

4.1.8.3. We will discuss the contentious issues, and try to convince the objector to reverse their vote.

4.2. Comment Resolution

4.2.1. Raju

4.2.1.1. Null QoS Data Subtypes

4.2.1.1.1. They are needed because a null data frame is reported to the LLC. A non-reported null is required to fill a TxOp to indicate status, and piggyback acks

4.2.1.2. RTS / CTS in CFP –

4.2.1.2.1. it is in document 360

4.2.1.3. Feedback with AID

4.2.1.3.1. Fixed in 360

4.2.1.4. txop flags are absent

4.2.1.4.1. because of change in continuation mechanism

4.2.1.5. Record Count – 0

4.2.1.5.1. It was overlooked, but will be put in , editorial

4.2.1.6. Advanced power category codes

4.2.1.6.1. This is to assign to subgroups so work can go on in parallel

4.2.1.6.2. Editor rejects category code, but will do action code. Accepted.

4.2.1.7. DFS / TPC element

4.2.1.7.1. In SMA subgroup.

4.2.1.8. TBTT / superframe in activation delay

4.2.1.8.1. Editor believes it is correct in the clause as written. (generic management action)

4.2.1.9. Container frame ack issue

4.2.1.9.1. Editor will check

4.2.1.10. Privacy capability bit

4.2.1.10.1. Gone , not QoS issue

4.2.1.11. Table 16 level 0

4.2.1.11.1. already in doc 360

4.2.1.12. TA, RA, TCID

4.2.1.12.1. already done in 360

4.2.1.13. Polling interval

4.2.1.14. retry interval in TU

4.2.1.15. Error statistics per TCIS

4.2.1.15.1. already done in 360

4.2.1.16. qbss activity change

4.2.1.16.1. will be made more clear

4.2.1.17. FEC frame format

4.2.1.17.1. already covered with placeholders

4.2.1.18. TBTT hard limit

4.2.1.19. Already there

4.2.2. Discussion from the floor

4.2.2.1. Do we need a black box on the Overlap mitigation mechanism?

4.2.2.2. Duncan has a resolution to propose:

4.2.2.3. Move that the specific definition of scheduling algorithm and channel access method to be used in level 1 QoS be temporarily replaced with a text placeholder in the baseline document; further to reiterate that as of the November 2000 meeting the call for proposals is closed, and text to replace the placeholder be based on existing proposals.

4.2.2.3.1. Moved Duncan

4.2.2.4. Discussion

4.2.2.4.1. The intention is to close the call for proposals.

4.2.2.4.2. Change to "call for QoS baseline proposals"

4.2.2.5. Move that the specific definition of scheduling algorithm and channel access method to be used in level 1 QoS be temporarily replaced with a text placeholder in the baseline document; further to reiterate that as of the November 2000 meeting the call for QoS baseline proposals is closed, and text to replace the placeholder be based on existing proposals.

4.2.2.6. Any objections to this resolution?

4.2.2.6.1. One concern – we might lock out a good proposal.

4.2.2.6.2. No, we could still entertain proposals, just not for the baseline.

4.2.2.6.3. Issue resolved

4.2.2.6.4. No further objections

4.2.2.7. Motion accepted

4.2.2.8. Is anyone else abstaining?

4.2.2.8.1. John K – over the whether QoS under DCF is useful.

4.2.3. Straw Poll

4.2.3.1. To the Previous "No" Voters, how many are still "No" votes?

4.2.3.1.1. Tom

4.2.3.1.2. Anil

4.2.3.1.3. Sunghyun

4.2.3.1.4.

4.2.3.2. How many have turned to "Abstained"

4.2.3.2.1. Raju and Matt F changed from No to Abstain.

4.2.3.2.2.

4.2.3.3. Now there are 8 "No's", and 5 Abstains

4.2.4. Discussion

4.2.4.1. John K – what would change abstain to yes would be to have objective comparison between levels.

4.2.4.2. Of those who object to Overlap BSS, would you be happier if OBSS was a black box?

4.2.4.3. In order to pass this baseline do we need 75% of all votes? Yes, abstains don't count.

4.2.5. Proposed Resolution

4.2.5.1. Matthew Sherman

4.2.5.2. Motion: Aggregate levels 1 and 2 into a level 1.5. in Level 1.5, support for both prioritized DCF and PCF would be mandatory. Note that while the CC/RR mechanism would be allowed at 1.5, their use would not be required. All STAs would need to support CF Poll.

4.2.5.3. Discussion

4.2.5.3.1. RR has nothing to do with the duration of the TXOP. It informs the PC that it wants TxOps.

4.2.5.3.2. This leaves the CF Poll and the TXOP limit.

4.2.5.3.3. Is the intent of this motion to replace level 1 with a requirement of implementing PCF and DCF? The intent is that adding CF Poll is a large overhead. A simple station can remain simple.

4.2.5.3.4. There is some disagreement of whether it is simple

4.2.5.3.5. The complexity is in the queues, not in being CF pollable. CF Pollable is trivial.

4.2.5.3.6. From the eyes of the consumer, there are still two QoS Levels. This partitions into prioritized and parameterized.

4.2.5.3.7. Does this affect the AP also? No, it is up to the implementer.

4.2.5.3.8. Edit Motion:

4.2.5.4. Motion: Aggregate levels 1 and 2 into a level 1.5. in Level 1.5, support for both prioritized DCF and PCF would be mandatory. Note that while the CC/RR mechanism would be allowed at 1.5, their use would not be required. All STAs would need to support CF Poll. The AP, as a practical matter could support either Prioritized PCF, prioritized DCF, or both.

4.2.5.5. Discussion

4.2.5.5.1. Is anyone ready to convert to a No Vote if this resolution is accepted?

4.2.5.5.2. Approximately 6

4.2.5.5.3. What is it that bothers the group?

4.2.5.5.4. The baseline specifies the PCF as an option. This forces the stations to implement both. Objects to that. This is contrary to the layering structure we agreed on.

4.2.5.5.5. We already have demonstrable systems on DCF now for simple apps.

4.2.5.5.6. The point is to gain consensus and make a standard. The ranges are making everything optional or everything mandatory. This is a reasonable compromise.

4.2.5.5.7. The purpose of the nesting is to insure interoperability.

4.2.5.5.8. Yes, we want one option, and it should be ours. Unfortunately, there are two differing groups

4.2.5.5.9. How do we judge what is difficult to implement?

4.2.5.5.10. The key requirement is interoperability

4.2.5.5.11. Anyone with PCF experience – if we were talking about CF-Poll as it is in the standard, would you have a problem? Yes.

4.2.5.5.12. Disagreement of whether you can implement a CF Pollable station.

4.2.5.5.13. One approach would be to bracket this issue, and wait until a decision process down the line.

4.2.5.5.14. If we can't agree, and find a way to resolve this, is it OK to allow the baseline with all the levels, and try to reduce the levels later.

4.2.5.5.15. The issue is the nesting, not the levels. We shouldn't assume that one possibility is in, or that any particular implementation is more complex.

4.2.5.5.16. Nesting is required for interoperability up and down the chain.

4.2.5.5.17. This is a question of what should be in the baseline. Not comfortable with a baseline that requires a DCF QoS.

4.2.5.5.18. Options are frowned upon and will generate No votes. Incompatible options will not be passed.

4.2.5.5.19. There is no dispute that the base compatibility level is DCF.

4.2.5.5.20. For the 11E standard, we cannot have incompatible options.

4.2.5.5.21. Comment on the NY times article on 802.11. When we argue about these issues, we are asking whether that we are ready to be a useful interoperable standard.

4.2.5.5.22. We agree that the goal is total interoperability. We are trying to move past a roadblock because of the two groups.

4.3. Recess until tomorrow

5. Wednesday Morning TGe QoS session

5.1. Opening

5.1.1. Objective

5.1.1.1. To have a baseline by the end of the week

5.1.1.2. It is better to have black box items in the baseline.

5.1.1.3. The security group has approved a baseline

5.2. Discussion

5.2.1. Level and Nesting Structure

5.2.1.1. Raju changes vote from Abstain to Yes

5.2.2. What can be done to make an acceptable baseline?

5.2.2.1. Could the motion of yesterday regarding level 1.5 be simplified to a requirement that all stations be able to support CF-Polling.

5.2.2.2. This would be OK, providing the CF-Polling response honors the TxOp opportunity time limits

5.2.2.3. How could an implementer who doesn't have a level 3 AP test their devices for CF-Polling?

5.2.2.4. WECA test equipment is being upgraded to verify CF-conformance. CF-Conformance will be required for WECA conformance.

5.2.3. Review of Matthew Sherman's motion for "Level 1.5

5.2.3.1. CF-Pollable stations must respond within time limit of

5.2.3.2. Suggestion that the "nesting" be deferred to later decision.

5.2.3.3. Leave the relative nesting of the solutions unspecified in the initial baseline proposal.

5.2.3.4. Discussion

5.2.3.4.1. All we are doing is deferring this decision until later.

5.2.3.4.2. We need to move forward, we can put off the fight until we have more information.

5.2.3.4.3. We need to be able to demonstrate that the proposal that is accepted allows for consumer AV products to work. We need more information

5.2.4. What is the data needed for a decision?

5.2.4.1. Data on relative complexity of implementation

5.2.4.2. Performance simulations

5.2.4.3. Before that, we need scenarios that define the problem.

5.2.4.4. The PCF group should clearly define what CF-pollable actually means in terms of implementation.

5.2.4.5. This applies to both sides – the DCF group needs to provide details of how DCF affects the PCF implementation.

5.2.4.6. Can a useful simulation be done? We will simulate the corner cases and stress cases.

5.2.4.7. Request for a "state diagram" to represent the operation of a CF-pollable

5.2.4.8. We know that under high load, the DCF schemes don't work well. The PCF group can accommodate higher load scenarios. We need to make the PCF support mandatory.

5.2.4.9. Belief that enhanced DCF can support an adequate application space.

5.2.4.10. Suggestion that a clause to require level 1 stations to be CF-pollable but bracket that clause for now.

5.2.4.11. No, if we bracket that clause, then bracket the whole thing.

5.2.4.12. The whole point is to get to two levels – we want to reduce the confusion.

5.2.4.13. If we take out the strict nesting, then interoperability becomes a problem.

5.2.5. Propose a compromise related to the 1.5 proposal.

5.2.5.1. Motion: Aggregate levels 1 and 2 into a level 1.5. in Level 1.5, support for both prioritized DCF and PCF would be mandatory. Note that while the CC/RR mechanism would be allowed at 1.5, their use would not be required. All STAs would need to support CF Poll. The AP, as a practical matter could support either Prioritized PCF, prioritized DCF, or both.

5.2.5.2. Levels 1 and 2 are replaced by 1.5

5.2.5.3. If you do this, the AP can still be built with DCF only.

5.2.5.4. From Matt's view, supporting DCF adds complexity to a PCF system.

5.2.5.5. There is a swap. If stations are CF-Pollable, the PCF systems will support DCF.

5.2.5.6. If level 1 allows CF-Pollable, how much difference is there with level 2? At the AP, there may not be PCF. Stations may be two levels, but APs can have 3.

5.2.5.7. We are asking for Stations to respond to CF-Polls, and limiting their response to the TxOp size.

5.2.5.8. The distinction is the Baseline CF-Pollable - call it QoS CF-Pollable

5.2.5.9. This does not make PCF mandatory

5.2.5.10. Instead of having the 4 levels as marketing issues, we can use them as semantics to describe features. We have already gone through the PCF DCF arguments. We have to allow some options there.

5.2.5.11. We were talking about adding a clause to require a station to respond to CF-Poll.

5.2.5.12. The question is supporting the CF-Poll time limit to a TXoP. What if the time isn't big enough? You send a QoS Null.

6. Wednesday AM Full TGe Working Group

6.1.1. Call to order the full TGe meeting

6.1.1.1. Full TGe called to order by John Fakatselis

6.1.2. Announcements

6.1.2.1. The security group has split into Ad Hoc

6.1.2.2. The TGe group will now recess for Ad Hoc also

6.1.2.3. Concerns

6.1.2.3.1. When will the full TGe meeting be held? Tomorrow.

6.1.2.4. Any objection to recess until tomorrow?

6.1.2.5. No Objections.

6.2. Recess of Full TGe until Thursday at 10:30AM

7. Wednesday AM QoS SubGroup

7.1. Review of open issues

7.1.1. Anil

7.1.1.1. Level 3 complexity

7.1.1.2. Persistent Polls

7.1.1.3. Aggregation

7.1.1.4. Delayed Acknowledgements

7.1.2. Sunghyhun

7.1.2.1. BSS overlap – request more details

7.1.3. Brian

7.1.3.1. More details of baseline

7.1.4. Wen-Ping

7.1.4.1. Levels

7.1.4.2. RR and CC mandatory or not

7.1.5. Khaled

7.1.5.1. Simulation Framework

7.1.6. Adrian

7.1.6.1. complexity of hardware implementation

7.1.7. Bob

7.1.7.1. Concern over Proxy Beacon and Overlapping BSS

7.2. Baseline Straw Polls

7.2.1. Straw Poll - voters

7.2.1.1. How many people object to the current baseline: 6

7.2.1.2. How many approve of the baseline – 0

7.2.1.3. How many abstain – 6

7.2.2. Straw Poll - voters

7.2.2.1. If the only change made to the baseline is Matthew's proposal of consolidating to level 1.5 how many object – 2

7.2.2.2. How many would approve - 5

7.2.2.3. How many would abstain – 9

7.2.3. Straw Poll – non voters. Original baseline

7.2.3.1. How many approve the baseline – 5

7.2.3.2. How many disapprove – 1

7.2.3.3. How many abstain – 9

7.2.4. Straw Poll – non voters, with Matthews proposal

7.2.4.1. Approve 0

7.2.4.2. Disapprove – 2

7.2.4.3. Abstain – 14

7.2.5. Straw Poll - voters

7.2.5.1. Putting levels/nesting aside, how many approve the baseline, with the compromises and issues that have been resolved (DCF in Black Box, and Raju's objections)

7.2.5.2. Approve - 12

7.2.5.3. Disapprove - 2

7.2.5.4. Abstain - 2

7.2.6. Straw Poll – non voters

7.2.6.1. Approve – 6

7.2.6.2. Disapprove – 0

7.2.6.3. Abstain – 10

7.3. Review of open issues

7.3.1. Anil's Complexity issue

7.3.1.1. There is a feeling that Level 3 is not needed to get QoS. Some new features are needed, but much is there for improved efficiency. Nobody has given any indication of the actual efficiency improvements.

7.3.1.2. We have a sub-group doing simulations. Their results will let us weigh the benefits. We will have results later today. The goal is to provide an efficient system that will provide prescribed QoS.

7.3.1.3. In terms of the schedule frame and the and the delayed ack, these parts of the baseline have been implemented, and in comparison to the existing 802.11, there is no comparison. The efficiency improvements from these enhancements are substantial.

7.3.1.4. Removing level 3 removes only parameterized QoS. Is that the intention?

7.3.1.5. No, the intention is to remove level 3 and put parameterization into level 2.

7.3.1.6. but that is the only difference.

7.3.1.7. Let's identify what you don't like in Level 3. ..

7.3.1.7.1. persistent polls

7.3.1.7.2. aggregation

7.3.1.7.3. delayed acknowledgement

7.3.1.8. Could these options be black-boxed?

7.3.1.9. The problem is with optioning things in QoS.

7.3.1.10. We don't want options within options

7.3.1.11. Wants one single QoS that meets all the needs.

7.3.1.12. Anil doesn't want to remove level 3, but he wants to remove the options.

7.3.1.13. Wants quantitative measures of efficiency improvements.

7.3.1.14. Greg P – The test work that has been done with schedule frames and persistent polls, and delayed acknowledgement, they work in a way that roughly doubles the channel utilization for MPEG streams compared to best-of-class 802.11b DCF AP devices.

7.3.1.14.1. 3Mbps using existing 802.11b

7.3.1.14.2. 6Mbps using these mechanisms.

7.3.1.15. This is especially effective for constant bit rate streams.

7.3.1.16. If these mechanisms are removed, then it is felt that level 3 would be useless for the required applications.

7.3.1.17. The reasons we have agreed to make level 3 an option is so that those who don't need the features don't have to implement them.

7.3.1.18. Level 3 requires a more complex AP, but not a station. The client gets more complex to decide how to best fill the TxOps.

7.3.1.19.

7.4. Procedural Clarification

7.4.1. The 802.11 Chair reviews the process of convening the full TGe Group and then recessing the Full TGe group into the two subgroups.

7.4.2. Everyone is still in full agreement with the procedure, with no objections.

7.5. Report from sidebar discussion

7.5.1. Proposed baseline modification

7.5.1.1. Modify the definition of level 1 ESTAs such that they will accept a QoS CF-Poll. The ESTAs will recognize the TxOP limit field and only respond with a data frame if it can accommodate that size. If not, the ESTA will respond with a Qos Null Frame which will include the priority of the highest

occupied queue and {the size of that queue or size of the frame at the head of that queue – TBD}. In addition, level 1 ESTAs will not need to recognize piggybacked Ack's. Instead an ACK will be used by the EAP for ESTAs that are level 1. However the ability to do so will be indicate by the ESTA during association.

7.5.2. Discussion

7.5.2.1. If the agree at association to support piggybacking they get both kinds of Ack's. If not, they just get regular acks.

7.5.2.2. Are there still 4 levels? Yes, and they are nested.

7.5.3. Straw Poll on the baseline

7.5.3.1. The baseline includes the compromises and changes yesterday, plus this resolution.

7.5.3.2. How many voters disapprove the baseline – 3

7.5.3.3. How many voters approve – 27

7.5.3.4. How many voters abstain – 3

7.5.4. Straw poll – non-voters

7.5.4.1. How many approve – 10

7.5.4.2. disapprove – 0

7.5.4.3. abstain – 10

7.5.5. Outstanding No Votes from voters

7.5.5.1. Anil

7.5.5.2. Tom

7.5.5.3. Jason

7.5.5.3.1. There should be one form of QoS to prevent marketing confusion

7.6. Review of open issues

7.6.1. Anil

7.6.1.1. Complexity at level 3

7.6.2. Tom

7.6.2.1. Wants no levels or options within 802.11E

7.6.3. Wen-Ping

7.6.3.1. Wants to use the same level 0 frames for PCF in level 2 and 3

7.6.4. Sunghyun

7.6.4.1. Needs details of BSS overlap.

7.6.5. Bob

7.6.5.1. Overlap BSS and Proxy Beacon mechanism

7.7. Recess the Ad Hoc

8. Wednesday Afternoon TGe SubGroup

8.1. Opening

8.1.1. Called to order at 4:00PM by John Fakatselis

8.1.1.1. This is the "real group" with official voting

8.2. Agenda

8.2.1. Proposed agenda for remainder of TGe QoS

8.2.1.1. Call to Order
8.2.1.2. Ad Hoc Submissions
8.2.1.3. Simulations Group Submissions
8.2.1.4. Comments and Issues on Baseline discussion
8.2.1.5. Motions for Plenary (full TGe)
8.2.1.6. Next Meeting Plans
8.2.1.7. Adjourn

8.2.2. Discussion on Agenda

8.2.2.1. None
8.2.2.2. Agenda adopted without objection

8.3. Ad Hoc Submissions

8.3.1. Matthew Sherman, Document 425

8.3.2. Resolution from sidebar discussion today:

8.3.2.1. Modify definition of level 1 ESTAs such that they will accept a QoS CF-Poll. The ESTA s will utilize the TxOP limit field, and only respond with a data frame if it can accommodate that size. If not, the ESTA will respond with a QoS Null frame, which will include the priority of the highest occupied queue, {and the size of that queue or size of the frame at the head of that queue - TBD}. In addition, level 1 ESTAs will not need to recognize piggybacked Ack's. Instead an Ack will be used by the EAP for ESTAs that are level 1. However, the ability to do so will be indicated by the ESTA during association.

8.4. Adoption of the QoS Baseline Proposal

8.4.1. Motion:

8.4.1.1. To accept Document 360r1, with modification by the following two resolutions, as the TGe QoS Baseline Proposal:

8.4.1.1.1. Move that the specific definition of scheduling algorithm and channel access method to be used in level 1 QoS be temporarily replaced with a text placeholder in the

baseline document; further to reiterate that as of the November 2000 meeting the call for QoS baseline proposals is closed, and text to replace the placeholder be based on existing proposals.

8.4.1.1.2. Modify the definition of level 1 ESTAs such that they will accept a QoS CF-Poll. The ESTAs will utilize the TxOP limit field and only respond with a data frame if it can accommodate that limit. If not, the ESTA will respond with a Qos Null Frame which will include the priority of the highest occupied queue and {the size of that queue or size of the frame at the head of that queue – TBD}. In addition, level 1 ESTAs will not need to recognize piggybacked Ack's. Instead an ACK will be used by the EAP for ESTAs that are level 1. However the ability to recognize piggybacked ACKs will be indicated by the ESTA during association.

8.4.1.2. Moved Matt Sherman

8.4.1.3. Second Duncan Kitchen

8.4.1.4. Discussion

8.4.1.4.1. Sunghyun - Motion to amend.

8.4.1.4.1.1. Withdraws Motion to amend

8.4.1.4.2. If we accept this motion, we have created a baseline document. We can still have subsequent motions to modify the baseline, even this week.

8.4.1.5. Vote on the main motion: passes 33:2:0

8.5. Simulation Results

8.5.1. Progress Report from Ad Hoc Simulation group

8.5.1.1. Matt Sherman

8.5.1.2. Document 372

8.5.1.3. Discussion

8.5.1.3.1. Matt requests a secretary for his meetings and conference calls

8.5.1.3.2. TCP/IP incorporates its own feedback mechanisms. Thus the TCP rate is interdependent on the MAC.

8.5.1.3.3. UDP is simple to model

8.5.1.3.4. We need to isolate the effects of the higher layer from the lower layer

8.5.1.3.5. To make the simulation results meaningful, we need the whole protocol stack.

8.5.1.3.6. You can't evaluate the MAC without evaluating TCP with it.

8.5.1.3.7. TCP is one thing, but we are trying to provide QoS to higher layer protocols, so we make sure we provide what the protocols need.

8.5.1.3.8. First we should look at the MAC on its own, and then higher layers.

8.5.1.3.9. Do we have a specific list of things that will be reported for each MAC? Greg came up with this – there is a question as to how much is enough.

8.5.2. 802.11 PCF Model Progress

8.5.2.1. Matt Sherman

8.5.2.2. Document 373

8.5.2.3. Overview

8.5.2.3.1. This work is not yet validated. We have work going on in OpNet and NS. We don't have a validation method yet.

8.5.2.3.2. Will plan to have a contributed model with our enhancements.

8.5.2.3.3. A number of modifications have been made to keep up with development, and to fix errors.

8.5.2.3.4. Currently simulating the model 3 scenario.

8.5.2.3.5. Dropped packets – when the DCF runs out of capacity, packets start to drop out of the buffers.

8.5.2.3.6. With the PCF, only the bulk data is dropped when the MAC is overloaded.

8.5.2.3.7. The PCF clearly maintains all QoS Streams.

8.5.2.3.8. The DCF couldn't maintain QoS, and the video was the first to be effected.

8.5.2.3.9. Dropped Packet is at the data interface, Dropped Frame is at the PHY interface. Retries are because of the Dropped Frames.

8.5.2.3.10. Delays – the lowest AID gets the best service in the PCF case. They are slightly differentiated, but all are very low delays on the order of 1mS. Bulk data is longer, but doesn't effect the QoS delays. This is not true in the DCF. Once the bulk data is added, all the streams suffer.

8.5.2.3.11. Video Conferencing and Audio. The streams in the AP when the bulk data was added were more effected.

8.5.2.3.12.

8.5.2.4. Discussion

8.5.2.4.1. The standard OpNet model has one queue. Matt added one additional for PCF. We will need to add more for the QoS MAC.

8.5.2.4.2. What is the differentiation between streams? We use AIDs, and the lowest get polled first.

8.5.2.4.3. What about the DCF? Any Differentiation? No

8.5.2.4.4. When the DCFs were run, was there a CFP? No the CFP was turned off.

8.5.2.4.5. This is a comparison of PCF vs DCF – does the PCF give good enough performance for those streams? In some sense, yes. There are a lot of other things that could make it better.

8.5.2.4.6. If this is good enough, and is not level 3, why do we need to have level 3?

8.5.2.4.7. Until we have level 3, we can't show the benefits.

8.5.2.4.8. This might be enough for a home network, but our applications are more challenging.

8.5.2.4.9. Just because the level of QoS is acceptable. Perhaps we could get more Mbps of data and still maintain the QoS.

8.5.2.4.10. The simulation group should show what the level 3 mechanisms buy us.

8.5.2.4.11. Some type of comparison with the EPCF would be interesting, and what conditions are specifically addressed.

8.5.2.4.12. We have conference calls every week. If someone has scenarios they want simulated, they should participate.

8.5.2.4.13. We had a document 2 meetings ago to create a flat playing field of the evaluation of the goodness of several alternative for a QoS MAC. What we have seen is the foundation for doing that. But we don't have the baseline modeled yet. This is a reasonable model of the existing standard's MAC.

8.5.2.4.14. Now there is a single baseline proposal. We will not be using it to evaluate competing proposals.

8.5.2.4.15.

8.6. Recess until tomorrow at 8:00AM.

9. Full TGe Thursday Morning Session

9.1. Call to order at 8:10 by John Fakatselis

9.2. Opening

9.2.1. Agenda Review

9.2.1.1. Security Reports

9.2.1.2. Qos Reports

9.2.1.3. Break

9.2.1.4. Motions

9.2.1.5. Activities between meetings

9.2.1.6. Next Meeting Agenda

9.2.2. Call for New Submissions

9.2.2.1. None

9.2.3. Agenda Adoption

9.2.3.1. No Objections

9.3. New Business

9.3.1. Report and Presentation from Security Subgroup

9.3.1.1. Document 419, Bernard Aboba, et al

9.3.1.2. Represents merger of proposals 163, 362, and 382

9.3.1.3. Discussion

9.3.1.3.1. If WEP keys are changed on the fly, why doesn't that provide adequate security?

9.3.1.3.2. The problem is the "wrapping" which can occur rapidly at high rates. Also, the enormous amount of known plaintext, which combined with key wrapping, causes significant weakness.

9.3.1.3.3. The only standardized mutual authorization method is Kerberos.

9.3.1.3.4. How would this work in a private environment? Home?

9.3.1.3.5. Kerberos would be moved into the access point. Then the users and passwords would have to be entered into the APs.

9.3.1.3.6. Diffie Hellman only derives a key, but does not do authentication.

9.3.1.3.7. What does it take to break AES or Radius?

9.3.1.3.8. The Security group will take an action item to quantify the weakness

9.3.1.3.9. Is Kerberos appropriate for the home market? How big is the code size? The Kerberos client is allegedly 10K. The server source is available, and is reported to be simple to incorporate, perhaps 20K of code.

9.3.1.3.10. Does this mean Kerberos is mandatory for 802.11? It is necessary for the AP to validate the keys.

9.3.1.3.11. Concern of whether we can standardize and specify higher level standards as part of a MAC standard? Recommended practice documents will be written to describe how the MAC works with them.

9.3.2. Report and Presentation from QoS Group

9.3.2.1. Document 358r1 (Michael Fischer)

9.3.2.2. Overview

9.3.2.2.1. Defining enhanced DCF and PCF mechanisms.

9.3.2.2.2. Current draft 360r1

9.3.2.2.3.

9.3.2.3. Discussion

9.3.2.3.1. What is the functional scale in the PCF mode? Scaling in terms of number of access points? It depends on the overlap management provisions, and how well they work.

9.3.2.3.2. Why was the max container length made 2 bytes smaller? For compatibility with the existing standard.

9.4. New Motions from SubGroups

9.4.1. Security Motion

9.4.1.1. Move to accept document 00/419 as the TGe Security Baseline

9.4.1.1.1. Moved Dave Halasz

9.4.1.1.2. Discussion

9.4.1.1.2.1. Is there a paper as well as the Powerpoint presentation? No, Before the full draft is written, the subgroup wants direction from the whole body.

9.4.1.1.3. Vote – passes 36 : 3 : 6

9.4.2. QoS Motion

9.4.2.1. To accept Document 360r1, with modification by the following two resolutions, as the TGe QoS Baseline Proposal:

9.4.2.1.1. Move that the specific definition of scheduling algorithm and channel access method to be used in level 1 QoS be temporarily replaced with a text placeholder in the baseline document; further to reiterate that as of the November 2000 meeting the call for QoS baseline proposals is closed, and text to replace the placeholder be based on existing proposals.

9.4.2.1.2. Modify the definition of level 1 ESTAs such that they will accept a QoS CF-Poll. The ESTAs will utilize the TxOP limit field and only respond with a data frame if it can accommodate that limit. If not, the ESTA will respond with a Qos Null Frame which will include the priority of the highest occupied queue and {the size of that queue or size of the frame at the head of that queue – TBD}. In addition, level 1 ESTAs will not need to recognize piggybacked Ack's. Instead an ACK will be used by the EAP for ESTAs that are level 1. However the ability to recognize piggybacked ACKs will be indicated by the ESTA during association.

9.4.2.1.3. Moved John Fakatselis

9.4.2.1.4. Second Duncan Kitchin

9.4.2.1.5. Discussion

9.4.2.1.5.1. This motion was approved in the QoS SubGroup 33:2:0

9.4.2.1.5.2. Do we need to re-ratify this as TGe? It doesn't hurt.

9.4.2.1.5.3. Is the closing of proposals for all or just EDCF? What was the intent? To take out the DCF mechanism. This text is reiterating something already decided.

9.4.2.1.5.4. What happens to proposals after this week? No one is prevented in bringing a proposal for discussion. They can still be considered.

9.4.2.1.5.5. Explain how the bridge portal would work. How do you make ESS's work if you bypass the distribution mechanism? The BP is a station that need not be an AP, but is connected to the DS.

9.4.2.1.5.6. The intention is to use the BP as an alternate DS. It is the only one there, not in addition.

9.4.2.1.5.7. Complaint that there are two subjects in the motion. Motion ruled out of order

9.4.2.1.5.8. New motion:

9.4.2.2. To accept Document 360r1, with modification by the following two resolutions, as the TGe QoS Baseline Proposal:

9.4.2.2.1. Move that the specific definition of scheduling algorithm and channel access method to be used in level 1 QoS be temporarily replaced with a text placeholder in the baseline document; and text to replace the placeholder be based on existing proposals.

9.4.2.2.2. Modify the definition of level 1 ESTAs such that they will accept a QoS CF-Poll. The ESTAs will utilize the TxOP limit field and only respond with a data frame if it can accommodate that limit. If not, the ESTA will respond with a Qos Null Frame which will include the priority of the highest occupied queue and {the size of that queue or size of the frame at the head of that queue – TBD}. In addition, level 1 ESTAs will not need to recognize piggybacked Ack's. Instead an ACK will be used by the EAP for ESTAs that are level 1. However the ability to recognize piggybacked ACKs will be indicated by the ESTA during association.

9.4.2.2.3. Moved John Fakatselis

9.4.2.2.4. Second John Kowalski

9.4.2.2.5. Discussion

9.4.2.2.5.1. Bridges are a TBD area. It will be filled in, and may be eliminated if it is a problem.

9.4.2.2.5.2. Concern that the BP is not in the baseline, not until it is fully thought out.

9.4.2.2.5.3. Move to amend the motion:

9.4.2.2.5.3.1. To add a resolution to remove bridge portals

9.4.2.2.5.4. Moved Dave Bagby

9.4.2.2.5.5. Seconded Bob O'Hara

9.4.2.2.5.6. Discussion

9.4.2.2.5.6.1. It is OK to have a bridge portal from a security and authentication perspective

9.4.2.2.5.6.2. All the bridge portal does is allow the portal to move to another location.

9.4.2.2.5.6.3. Against amendment, as it is useful for many environments.

9.4.2.2.5.6.4. The concept is related to a home network with one BSS with multiple paths to outside the BSS. EX a DSL modem and an Ethernet on another. But there is still one BSS. Against this amendment.

9.4.2.2.5.6.5. This is attempting to define a DS as part of the MAC, which conflicts with the MAC charter

9.4.2.2.5.6.6. Moves to call the question

9.4.2.2.5.6.7. moved Dave Bagby,

9.4.2.2.5.6.8. No opposition – question called.

9.4.2.2.5.7. Vote on the amendment – fails 2 : 35 : 10.

9.4.2.2.6. Discussion on the main motion

9.4.2.2.6.1. Anil's objections – related to complexity vs benefit of Level 3. The issue of scheduled TxOps. Doesn't support efficiency improvements. Believes there is a problem with delayed ack's also.

9.4.2.2.6.2. From the standpoint of getting AV devices to operate, some form of aggregation is necessary. This can be demonstrated at the next meeting. In favor of the motion.

9.4.2.2.6.3. The information should be presented to contrast aggregation with bursting to be presented at the next meeting.

9.4.2.2.6.4. Addressing the complexity of level 2. Wants to use level 0 channel access mechanism for level 2 PCF. Speaks for the motion.

9.4.2.2.6.5. Is it true that RR and CC are allowed in level 2? They are allowed but not required.

9.4.2.2.6.6. The formats in the baseline document are considered reasonable as proposed.

9.4.2.2.6.7. Call the question

9.4.2.2.7. Vote on the main motion – 38 : 4 : 8

9.4.3. Editorial Motion

9.4.3.1. Move to instruct the editors to develop the initial TGe draft and make it available by the January 2001 Interim meeting based on the approved baselines by the two TGe subgroups.

9.4.3.1.1. Moved Duncan Kitchin

9.4.3.1.2. Second Sri

9.4.3.1.3. No Discussion

9.4.3.1.4. Vote – passes 39 : 0 : 1

9.5. Planning for next meeting

9.5.1. Inter-meeting Ad Hoc Activities

9.5.1.1. Dave Halasz announces that the Security group will have an Ad Hoc meeting on November 28th, in Portland OR., for 1 day. The purpose is to work on drafting text for the baseline.

9.5.1.2. John Fakatselis announces the continuation of weekly Ad Hoc teleconferences for QoS.

9.5.1.2.1. Dates – Nov 15, Nov 29, Dec 6, Dec 13, Dec 20, Jan 3, Jan 10..

9.5.1.3. Matt Sherman announces that the QoS Simulations/Metrics and Criteria group will continue weekly conference calls. Next week will be off, but the following week will re-convent.

9.5.1.3.1. Date – Tuesday, Nov 21 at 1:00PM EST, and weekly thereafter.

9.5.2. Goal for the January Meeting and overall schedule.

9.5.2.1. By January we expect to start the balloting process within the TGe task group.

9.5.2.2. May is the projected date to go to Sponsor Ballot.

9.5.2.3. July to submit to the board for approval.

9.5.2.4. Discussion on schedule

9.5.2.4.1. None

9.6. Motions for the Plenary

9.6.1. Baseline will be passed to the plenary session for approval

9.7. Closing

9.7.1. Final Discussion

9.7.1.1. In the proposal to have the fix for WEP with RC4, we do not address weak key attacks. We didn't know whether peoples hardware could support the needed functions. What is necessary is that after the key schedule is initialized, you have to step through the key sequence by 256 bytes before encoding/decoding.

9.7.1.2. Asks for vendors to examine their hardware to see if they can support this for a short term fix.

9.7.1.3. There will be a discussion on the reflector.

9.7.2. Announcement

9.7.2.1. Everybody that has contributions must provide to IEEE an IP statement. From companies, not individuals. Talk to Al Petrick for guidance and examples. The statement to be addressed to Stuart and 802.11. The company position must be declared. It must be submitted by the beginning of the January meeting.

9.7.3. Adjourn at 11:45AM

EXHIBIT E

Baseline D-QoS Proposal

Greg Chesson- Atheros
Wim Diepstraten- Lucent Technologies WCND
Duncan Kitchin- Intel
Harold Teunissen- Lucent Technologies
Menzo Wentink- Intersil/NWN

Prepared by: Wim Diepstraten

QoS Requirements

- The reigning network paradigm is IP - not ATM or circuit switching
- IP performance is inherently variable
- Multi-media applications for IP based networks include - or will include - pacing mechanisms to adapt to available capacity
  - e.g. the new MPEG4 standard allows continuous adaptation of the encoder to available capacity
- Distributed QoS is aiming to take advantage of these developments and focus on:
  - maintaining [reasonable] performance in the presence of interference
  - maintaining delivery rates rather than tight delay constraints per packet
  - accommodate rate adaptation

Assumptions

- The Enhanced DCF proposal is part of a total QoS proposal which is layered as follows:
  - QoS Level 0: No QoS using DCF & PCF as in 802.11 1999
  - QoS Level 1: Priority based QoS delivery using enhanced DCF
  - QoS Level 2: Priority based QoS delivery using enhanced DCF & PCF
  - QoS Level 3: Parameterized QoS delivery using enhanced DCF & PCF
- Each successive level does support the full functionality of the level below.
- Use priority based interface supporting 8 Priority classes according to 802.1d Annex H.2.

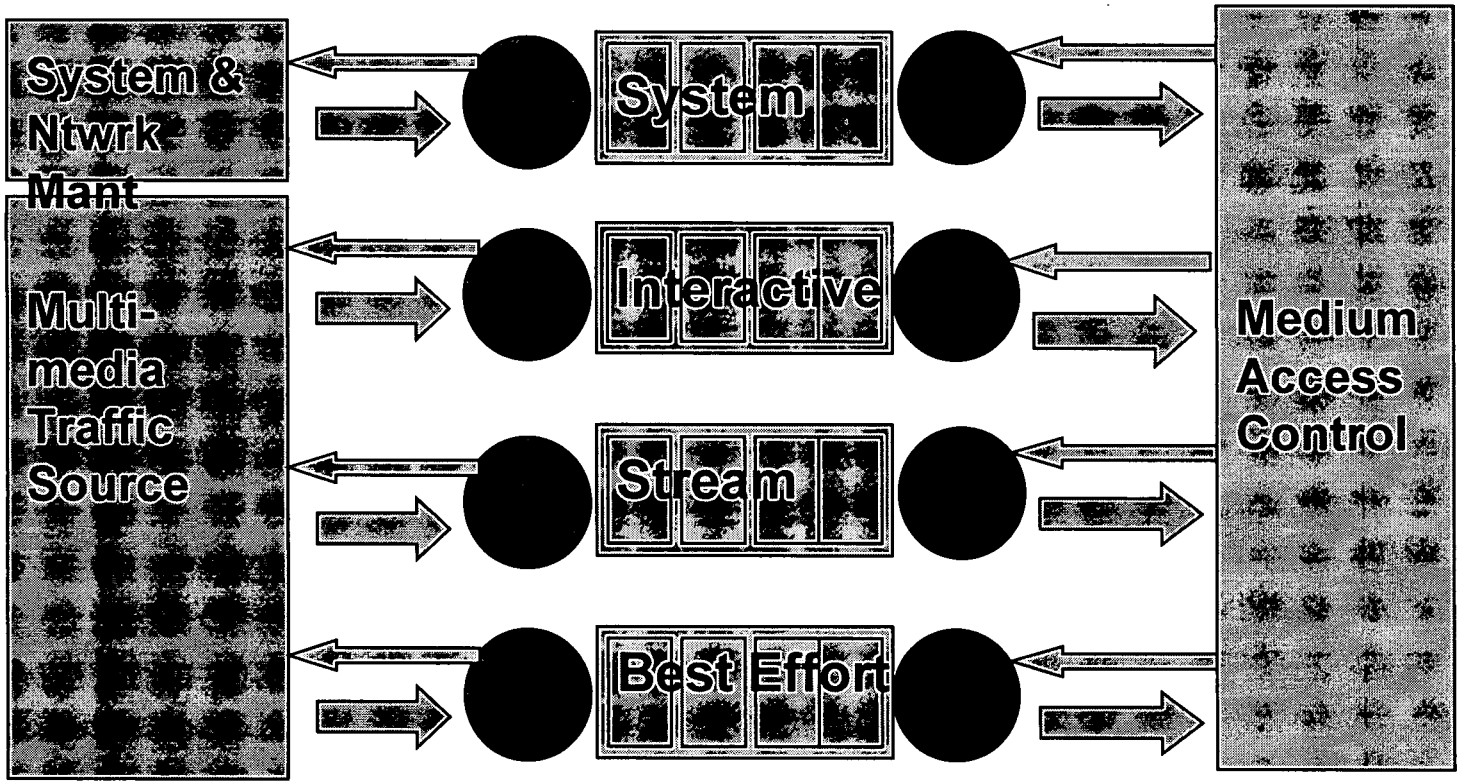
D-QoS objective

- Objective is to use a low complexity approach.
- Provide priority driven service differentiation between a number of different traffic priority classes.
- Provide mechanisms to limit the medium load in order to keep the delay of higher priority classes under control.
  - While avoiding starvation of low priority classes.
- The mechanism should be adaptive such that priority class differentiation mechanisms are only active when there is active traffic load in higher priority classes.
  - If there is only "Best Effort" traffic load, then the throughput performance should be similar to the legacy throughput.
- Should be able to provide priority differentiation also in the presence of legacy DCF devices, although effectiveness can be reduced.
- Can be applied in both ESS and IBSS.

Approach

- Up to 8 priority categories are distinguished, each having a separate Q.
  - Mapping to a limited subset of about 4 may be more practical.
- Objective is to control the total medium load such that the delay of high priority classes are acceptable.
  - There are no absolute limits, only relative.
- By using the medium load feedback to control the distinction between service classes.
  - By reducing the service rate of lower classes to assure better service of higher priority classes when load increases.
  - If this load feedback is indicating the load per priority class on the medium, then the differentiation model can be adaptive to scale up the lower priorities, when no traffic is present for any of the higher priority classes.
    - So that performance of "Best Effort" only traffic remains as is.
- The same distinction in service within a station should work across the whole BSS.

Basic model for example



Model discussion

- A limited number of Access Priority Q's are defined, and 4 is considered a good limit.
  - Standard will need to define min number of Q's (3-4)
- Two basic functions are provided:
  - "Service Rate Control" mechanism that is to assure service differentiation between priority classes by using different access priorities.
    - A Scheduling mechanism is to determine which priority category is going to use the next Transmit Opportunity, that is provided by the Access Control mechanism.
  - A "Drop Rate Control" mechanism that is to regulate the "Offered Load" based on medium capacity limits.
    - This is NOT considered a subject for standardization.
    - Objective is to utilize the congestion control mechanisms in higher layers to control the "offered load".
- Apart from this there can be a "Submission Control" function above the MAC.

Basic D-QoS concepts

- A "Medium monitor" function does measure the "Load per Class" in terms of medium occupancy duration, over a period, of for instance a Beacon interval.
- The "Medium monitor" function does translate the "Load per Class" into a set of COx,CWx parameters, which should be the same for all stations.
  - The COx,CWx parameters are distributed in a "Contention Control" element in every Beacon.
  - How this translation takes place is assumed NOT to be standardized.
- A "Virtual-DCF" (V-DCF) mechanism is used for each priority class within a station, each using a separate CWmin (CWx, a per class parameter), and a CO (Contention Offset) parameter.
  - So in our example there are up to 4 DCF contenders within each station.
  - The "V-DCF" mechanism does generate a separate backoff count per "Access Priority" level.
  - Which individually decrement when the medium is not busy.
    - A transmission starts when one of the counters decrements to zero.
  - A collision between local accesses are resolved locally.
    - The higher priority frame will be send first, while the lower priority it collided with should act as if it is to defer on a Tx-Opp, so would do an other backoff.

ESS / IBSS

- In ESS the "Monitor Function" is done in the AP.
  - The translation from "Load per Priority" to the COx,CWx value per class, is NOT specified in the standard, and can be policy based.
    - The Policy management only needs to be done in the AP, and applies identically in the whole BSS.
    - So that the whole BSS uses the same COx,CWx values.
  - A list of CWx parameters are distributed to each station in the Beacon.
- There can still be a "Monitor function" active in a station, which can further tune the COx,CWx parameters to the locally monitored situation.
    - The AP supplied parameters are considered the default.
    - But only unidirectional CW changes (getting larger) are allowed from the AP supplied CWx values.
- In an IBSS a default COx/CWx map is assumed, but a COx/CWx distribution by a "Load Monitor" function in any of stations will override the default.
  - In IBSS a 'Load Monitor" function is not mandatory, but if available will be used.

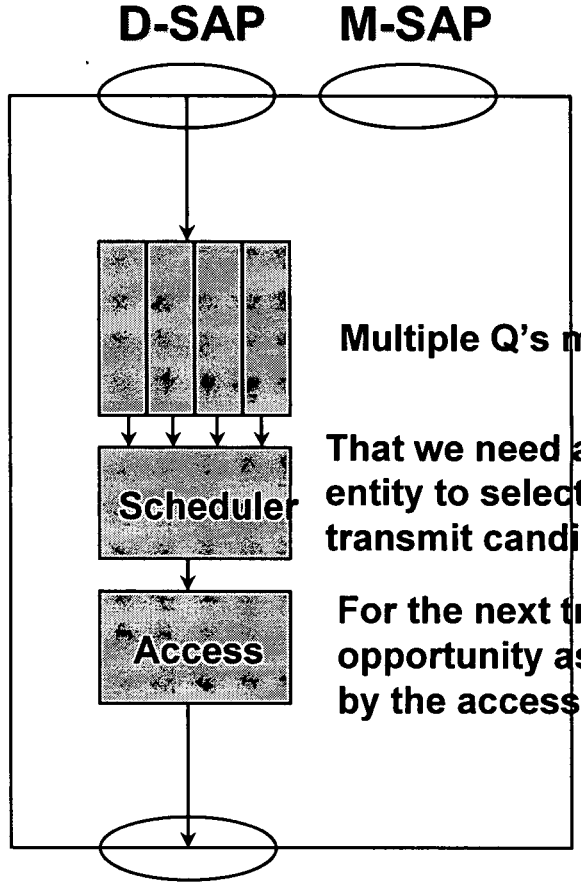
General Framework

802,1q D-SAP,
3-bit traffic class

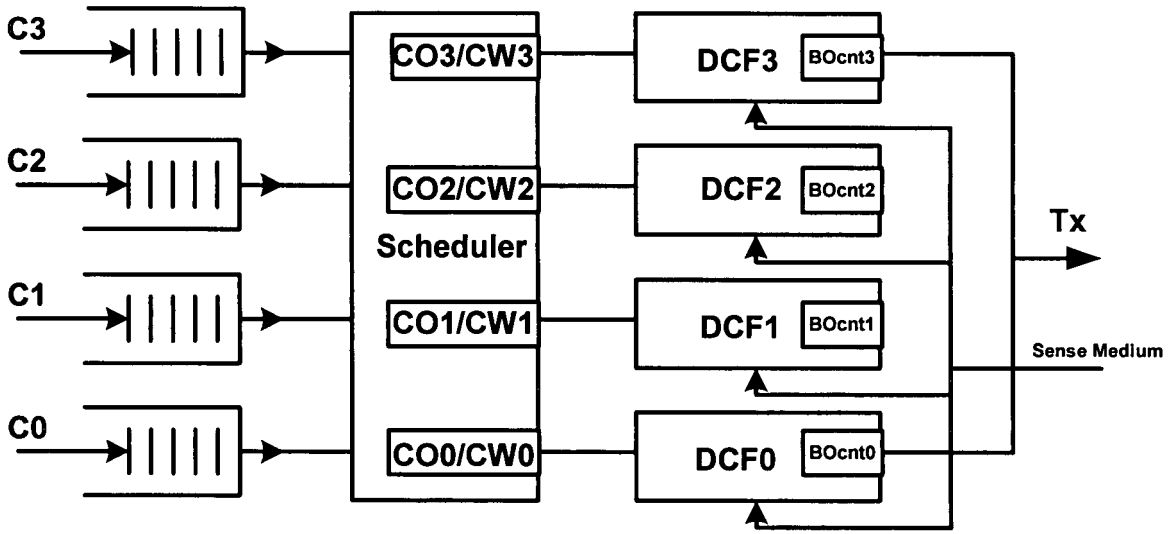
Number of Q's depends on QoS level

MPDU Scheduler

Channel access function independent of scheduler

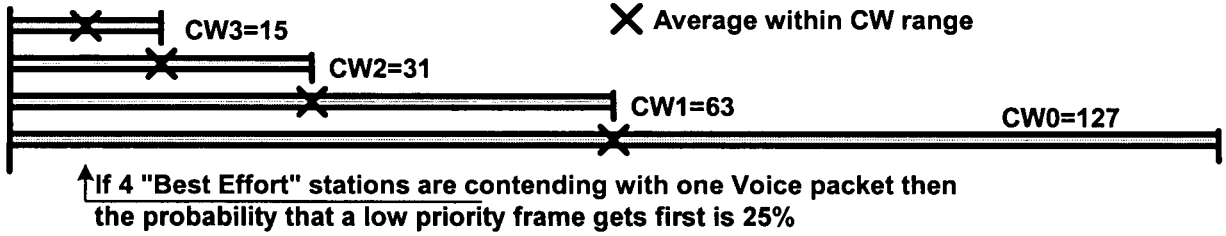


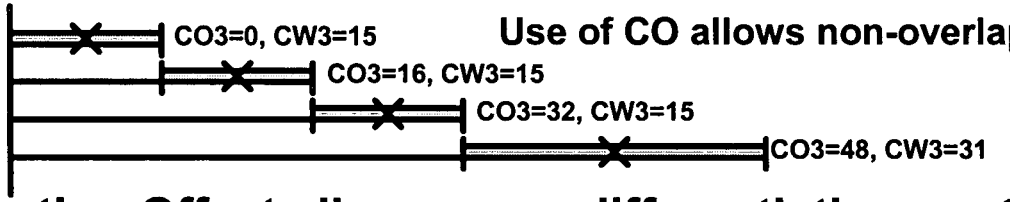
V-DCF mechanism



- **Access differentiation controlled by a Contention Window (CWx) and a Contention Offset (COx) parameter per priority category x.**
  - **Multiple DCF's running in parallel, with conceptually an individual Backoff counter for Backoff and Post-Backoff.**
    - **Formula for Backoff = COx+RND(CWx) (for legacy CO=0, and CW=31)**
    - **Implementations based on a single Delta-Backoff counter are possible.**
  - **The scheduling function is based on random number generated per access priority level, using individual COx/CWx parameters causing differentiation in access ratio**
  - **At a local collision the highest priority frame is being transmitted, while the other DCF is deferring and generate a new Backoff.**

Contention Offset





Use of CO allows non-overlap differentiation.

- Contention Offset allows more differentiation control
  - with more predictable differentiation independent of the number of contenders.
  - With better delay characteristics, because chance that lower priority will precede a higher priority packet is reduced.
    - Can still be possible that a low priority frame already in backoff due to a previous contention can precede a new high priority frame.
- Contention Window (CW) parameter can be chosen as function of the number of stations that are contending for medium access.
- A Contention Offset (CO) parameter can be used to assure that different priority categories do get a distinct advantage over the others to get access to the medium.

V-DCF example

- AP can change the parameters when load increases, to reduce service for lower priorities, to keep the delay for high priority traffic within bounds.
  - It also has knowledge of the number of contenders per priority category.
- If no load is monitored by the AP, then the relative priority of lower categories will improve.
  - So if only "Best Effort" traffic is present then performance is equal to legacy today.

• Example:Low load	All classes active	High Load
– C3: CO3=0, CW3=15	Voice, short frames no backlog low load	CO3=0, CW3=15
– C2: CO2= 8, CW2=15	Interactive, bursty, few stations medium load	CO2=16, CW2=15
– C1: CO1=16, CW1=15	Streaming, bursty, few stations, high load	CO1=24, CW1=15
– C0: CO0=32, CW0=31	Best Effort, bursty, more stations	CO0=40, CW0=63
• Example:Low load	Only C3 and C0 active	High Load
– C3: CO3=0, CW3=15	Voice, short frames no backlog low load	CO3= 0, CW3=15
– C2: CO2= 8, CW2=15	Interactive, bursty, few stations medium load	CO2= 8, CW2=15
– C1: CO1= 8, CW1=15	Streaming, bursty, few stations, high load	CO1= 8, CW1=15
– C0: CO0= 8, CW0=31	Best Effort, bursty,more stations	CO0=16, CW0=31
• Example:Low load	Only C1 and C0 active	High Load
– C3: CO3= 0, CW3= 8	Voice, short frames no backlog low load	CO3= 0, CW3= 8
– C2: CO2= 0, CW2= 8	Interactive, bursty, few stations medium load	CO2= 0, CW2= 8
– C1: CO1= 0, CW1=15	Streaming, bursty, few stations, high load	CO1= 0, CW1=15
– C0: CO0=16, CW0=31	Best Effort, bursty,more stations	CO0=32, CW0=63

V-DCF retry mechanism

- **Functional Goal:**
  - **Exhaustive Retry is to be prevented, when there is higher priority traffic Q'd up.**
  - **Objective of the retry mechanism is to temporarily reduce the load of the station on the medium for stability reasons.**
    - **To improve the probability of contention resolution success under high load conditions.**
    - **And to circumvent possible hidden interferers causing the failure.**
- **vDCF mechanism:**
  - **Therefore the whole station (all vDCF's) need to back off, and not only the vDCF that experience a failure.**
    - **So all DCF's need to double their CW's and generate a new backoff**
    - **Preferred CO behavior to be determined.**

Legacy Device Handling

- Legacy devices are assumed to use the CWmin=31 and contend with the priority traffic in a way that breaks the differentiation model.
  - For those priority levels that do not use a lower then 31 CWmin.
- However all traffic from legacy devices will go through the AP.
- So an "Enhanced DCF" AP does put the down traffic in the lowest priority Q.
  - Management frame responses could be an exception.
- In most higher layer protocol environments this will automatically reduce the traffic in the up direction.
  - AP's could implement an even lower priority Q for its legacy traffic, so that it bandwidth is extra reduced to balance this further.
- If we assume that the number of stations that generate high priority traffic is very limited, then a lower CWmin then 31 can be used, which improves the relative priority compared to legacy traffic.

Burst mechanims

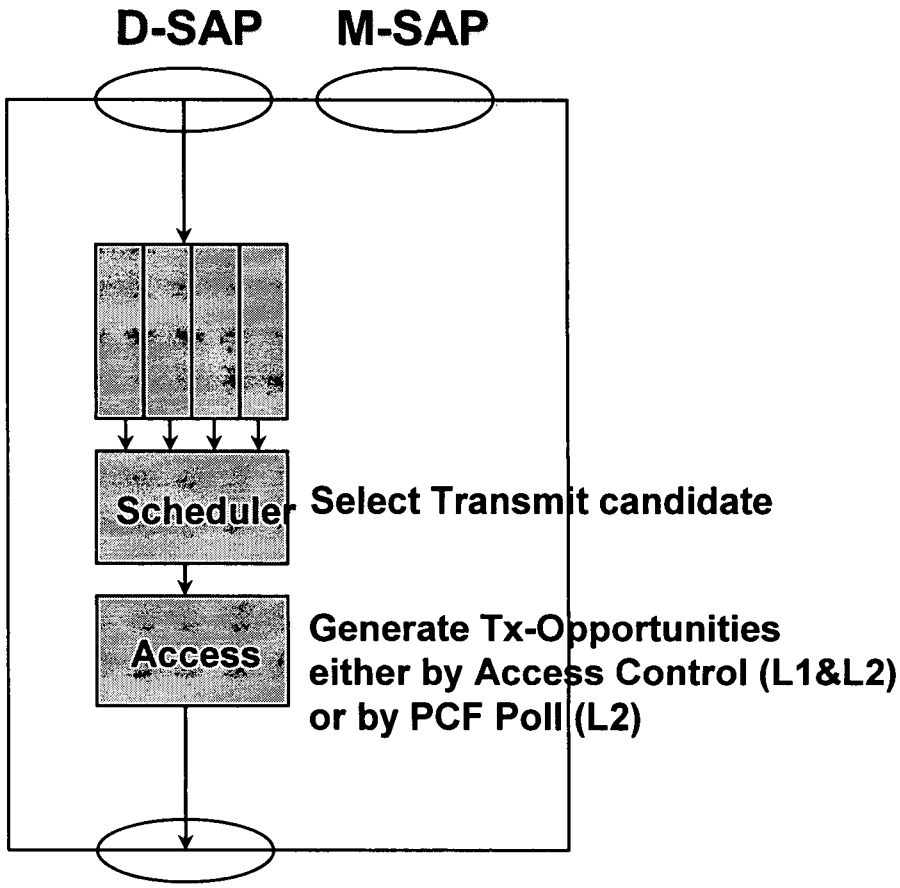
- In order to improve the efficiency of the AP, the AP should be allowed to concatenate multiple frames in one Tx-Access Opportunity.
  - A (MIB?) limited burst of frames are allowed per access opportunity with SIFS in between.
  - This can be done in a similar way as specified for fragmentation.
    - With the "Duration" field containing the proper values for the next exchange.
    - So Ack contains the duration of the next data frame, and its associated Ack.
- Also a station can be allowed to send a burst, but limited to a max size (2304 Byte) duration equivalent size.
  - We probably need to limit this functionality only to a 2304 Byte duration equivalent for the highest Basic rate only.
    - To prevent excessive jitter.

Burst Control

- A Tx-Opp limit mechanism can be used to reduce excessive medium occupancy situations, while allowing rate fallback.
  - In both AP and Stations which could be different.
  - The Tx-Opportunity Limit is a certain medium occupancy time limit per channel access.
    - Dimensioned to define the Burst duration which could range to a number of max size frames when transmitted at the highest basic rate.
  - If stations want to do rate fallback to for instance 1 Mbps for robustness, then that means that the station is forced to use fragmentation.
    - But contend for the medium between each fragment.

Framework

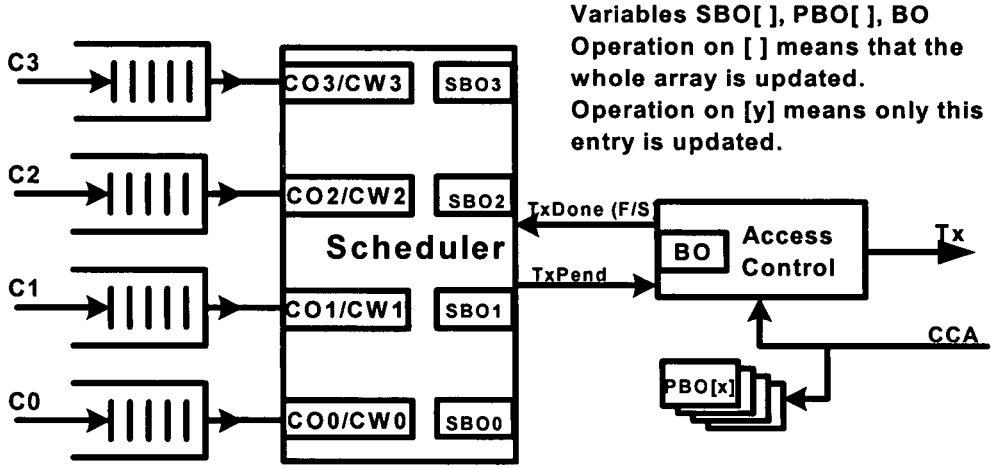
- 802.11 D-SAP
  - with 3 bit Traffic Class.
- Number of Q's depends on QoS level.
- MPDU scheduler
- Channel Access function
  - One or more, depending on Level.



Basic frame work approach

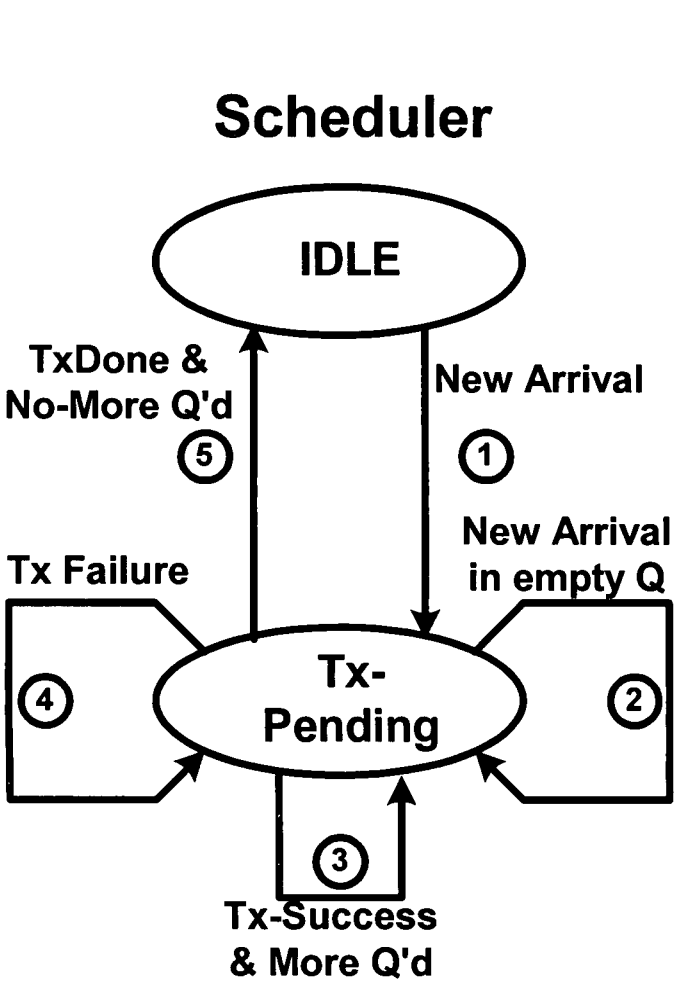
- Basic framework should conceptual work for both level 1 and level 2 station mechanism.
  - During CFP the random number generation aspect of vDCF can be the schedule mechanism.
    - While the PCF determines the Tx-Op
  - During the CP the vDCF scheduling and access mechanism is active.
    - Where the parallel DCF backoff mechanism is generating the Tx-Ops.
- The State Machines are setup to allow the use of the same scheduler mechanism for both Level-1 and Level-2 operation.
  - While the same differentiation control from the AP can be used also during level 2 operation during the CFP.
  - But its use is not mandatory. Each implementer can chose its own scheduler while in Level 2.
- The State Machines are described such that the behavior is becoming identical to the Legacy DCF when the number of Q's is reduced to 1.
  - Assuming CO=0 and CW=31

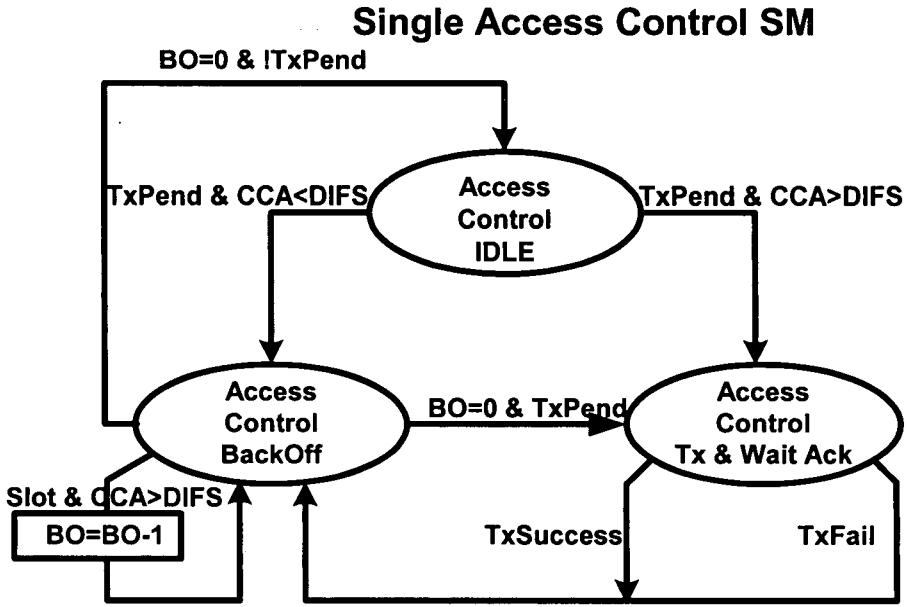
vDCF State Machine approach



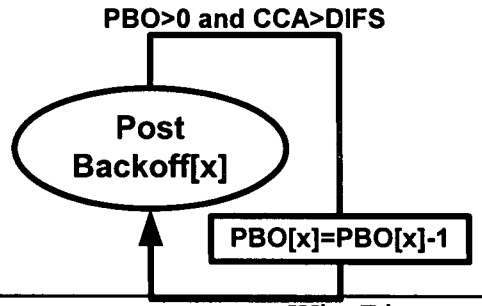
- Same Scheduler could be used for both Level 1 and Level 2
  - Generating a "Scheduler Backoff" (SBOx) per Q entry
  - The scheduler identifies the Tx candidate by choosing min(SBO[ ]).
    - » And adjusts SBO[ ]=SBO[ ]-min(SBO[ ])
  - And a next "Delta-BO" BO= min(SBO[ ]) is calculated for use in a single Access Control Engine.
- The Access Control engine is maintaining a single Backoff counter (BO)
  - which is invoked unless CCA>=DIFS (CCA active longer then DIFS time), and decremented on Slot Events when CCA>=DIFS.
- Individual Post Backoff SM's (PBO counter only) per priority category.

State Machines





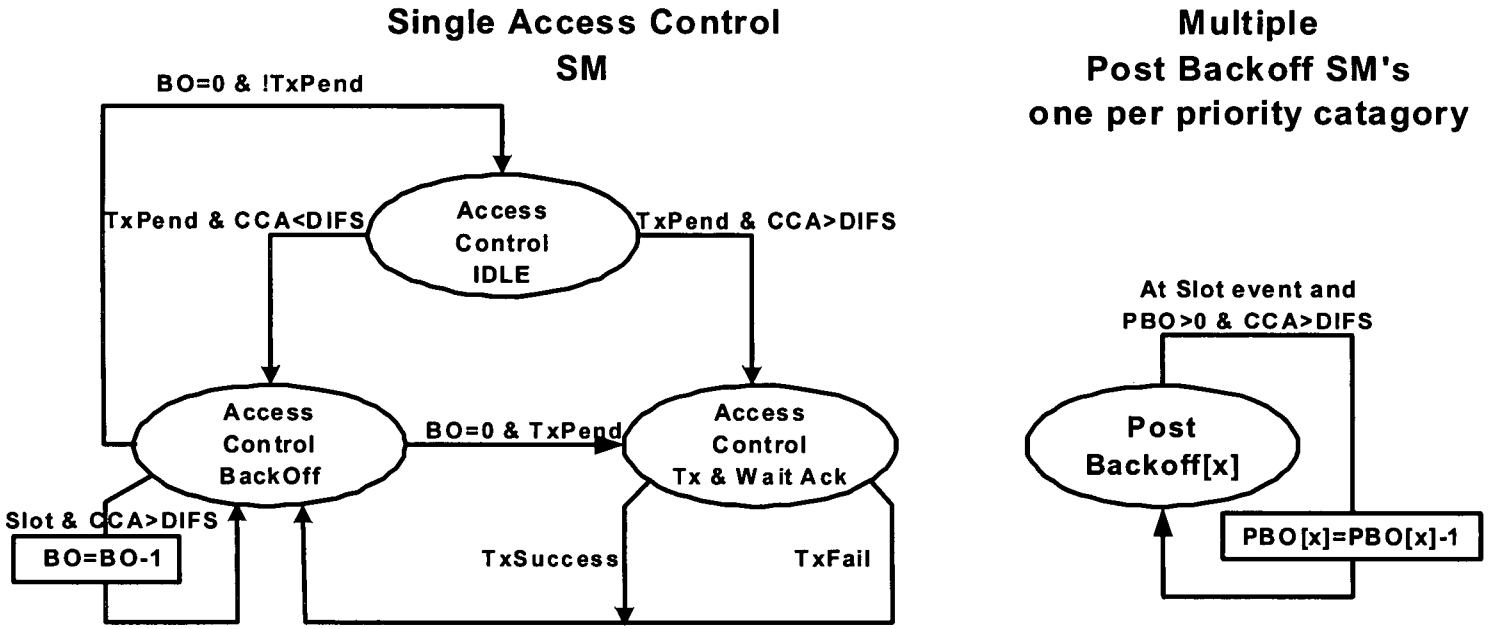
Multiple
Post Backoff SM's
one per priority catagory



Scheduler

- Scheduler with "Idle" and "Tx-Pending" states.
- Action description:
  - 1: New arrival of a frame in a Q.
    - Since Y is the first frame it is the Tx Candidate so generate BO=CO[y] + RND(CW[y]) unless still in Post Backoff, then BO=PBO[y].
    - Transit to Tx-Pend(ing) state.
  - 2: New arrival of a frame in an empty Q, (while an other Tx already pending).
    - Generate an SBO[y]=CO[y] + RND(CW[y]) unless still in Post Backoff, then SBO[y]=PBO[y].
    - If SBO[y]<BO then this frame has higher priority then the current scheduled frame, so it can still use the next TxOpp. The SBO of the other priority categories need to be adjusted accordingly so SBO[ ]=SBO[ ]+(BO-SBO[y]), and BO=SBO[y].
  - 3: Succesfull transmission, while more traffic Q'd.
    - 3a: If more traffic in this Q then generate SBO[y]=CO[y] + RND(CW[y])
    - else need to load the PBO[y]=CO[y]+ RND(CW[y]).
    - Reset all CW[ ]=Cwmin[ ]
    - 3b: If More Q'd Then select a new Tx Candidate according to BO=min(SBO[x]).
      - And adjust all SBO's by SBO[ ]=SBO[ ] - min(SBO[ ])
      - If lower priority SBO=0 then resolve this local collision by generating new SBO[z]=RND(CW[z])
  - 4: Transmit Failure
    - If Retrycount[y] > limit then Flush frame and proceed with 3b action.
    - Inc Retry count, make all CW[ ]=Limit.MaxCW(2*CW[ ]),
    - and generate new SBO[ ]=CO[ ] + RND(CW[ ]) for all Q's and proceed with 3b action.
  - 5: Transmit Done & no-More traffic Q'd:
    - Generate Post Backoff by PBO[y]=CO[y] + RND(CW[y]), and transit to Idle state.

Access Control SM's



- There is one "Access Control" State Machine
  - when active is either in "Backoff" or "Tx & Wait" state.
  - The interface from the Scheduler will be via the TxPend and BO variables.
- There are multiple "Post Backoff" State Machines, one per priority category.
  - Communicating with the Scheduler via the PBO[x].

DCF comparison

- **Legacy DCF**
  - 1 Tx-Queue
    - CW = fixed
  - Access Control
    - BO (Backoff counter)
    - PBO (Post Backoff counter)
- **Level-1 D-QoS**
  - N Tx-Queues
  - vDCF Scheduler
    - CO[ ], CW[ ] from AP
  - Access Control
    - BO (Backoff counter)
    - PBO[ ] (Post Backoff counter)
  - Burst / Aggregation?
- **Level-2 (in CFP)**
  - N Tx-Queues
  - Scheduler
    - v-DCF: CO[ ], CW[ ] from AP
    - or other method
  - Access Control
    - PCF
  - Burst / Aggregation
- **Level-3 (in CFP)**
  - N Tx-Queues
  - Scheduler
  - Access Control
    - PCF
  - Aggregation

Mechanisms needed

- Priority in frame header
  - a new field compatible with also the PCF approach needs to be defined.
- D-QoS Element in the Beacon
  - Containing the COx/CWx list per access priority level.
  - Which can also provide the "Total Load" info, which can be used for "Load Balancing" purposes.
- Rules to use CO/CW and retry change
  - See elsewhere in this document.
- Sequence# generation and Duplicate detection rule changes.
  - To support the non-exhaustive retry approach in a station, it is needed to maintain a sequence# per SA.Class combination.
    - So the sequencing rules need to change, such that individual S# is maintained per Class, and will increment.
    - And AP's and Station receivers need to maintain duplicate detection mechanism on a SA.Class basis, and expand its resources for that.
    - Capability exchange mechanisms to determine service levels.

EDCF Simulation

- Objectives
- EDCF Method
- Environment
- Scenarios
- Results
- Next Steps

Objectives

- Test CW-based access methods
  - MAC algorithm correctness
- Demonstrate differentiated service
  - Does DQoS exercise real control?
- Explore in overload and dynamic states
  - How good is it?
  - Is it "good enough"?

Non-Objectives

- 100% high-fidelity real-life model
  - Stimulus system less important than analysis
- Overlapping BSS (though possible)
- Mobile Stations
  - Unused facility is available in the system
- Full-function AP
  - Needed later

EDCF Access Method

- **Normal DCF window** [0 ---------- CW]
- **Vary rhs (CW x)** [0 ---------- CWx)
- **Vary lhs (CO x)** (CO x ---------- CW]
- **EDCF: Adjust both** (CO x ---------- CWx)

Environment

- Berkeley Network Simulator (NS 2)
- Modifications and additions
- Tarball for Linux or Solaris: greg@atheros.com
- What it does:
  - Tcp/ip/udp stacks, various traffic generators
  - Single priority stream per node, settable CW/CO
- What it does not do at this time:
  - Preserve priority when forwarding through AP
  - Demonstrate VDCF collision resolution
  - Change CW/CO settings dynamically
  - Bursting or aggregation

Scenarios

- Model 1: Simple Uniform Traffic
  - N nodes (plus AP)
  - N tcp/ip streams as infinite sources/sinks
  - 4 access classes
  - Adjust PHY bandwidth, N nodes, MTU size and the MAC parameters
- Goal: observe differentiated service

Scenarios

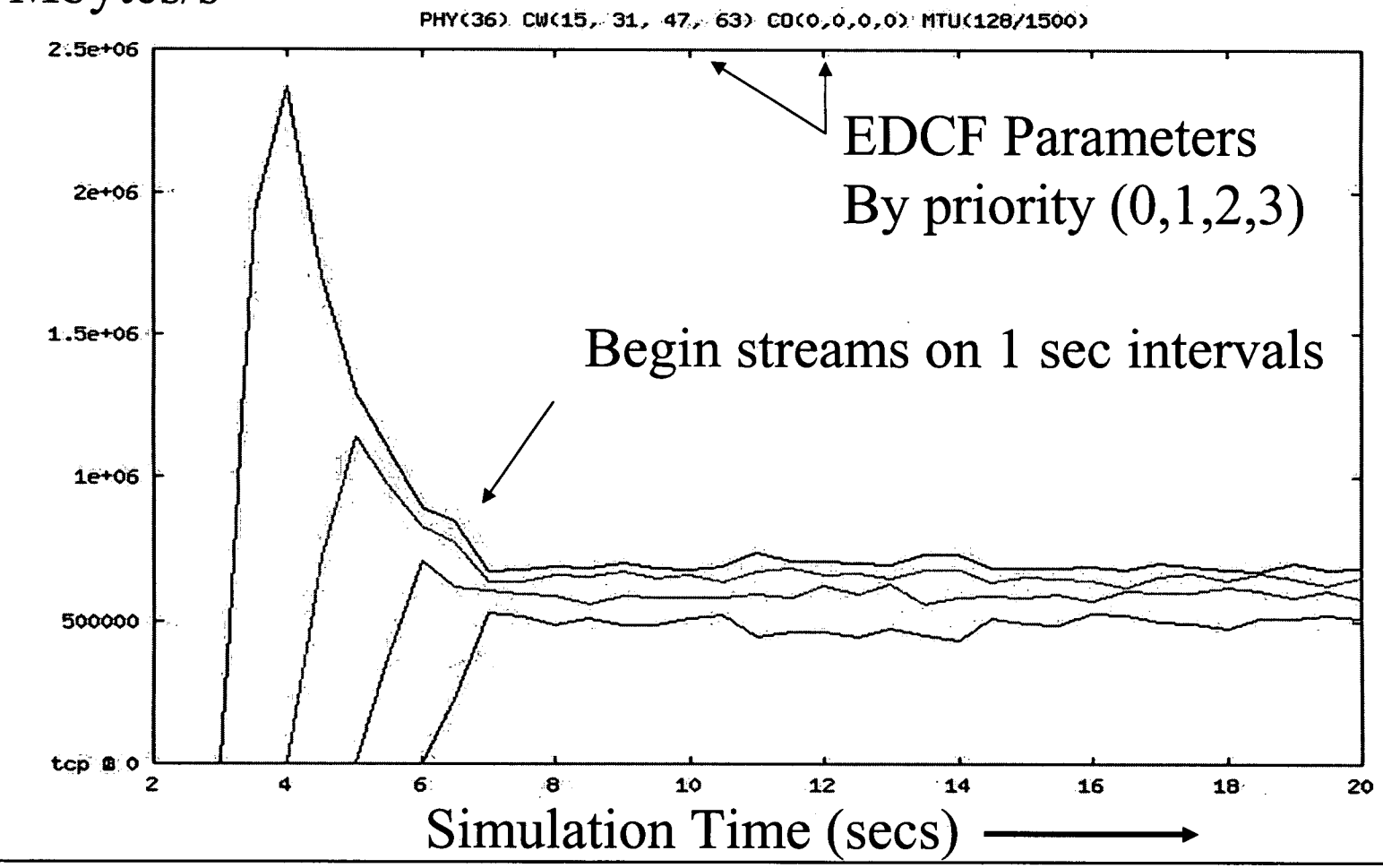
- Model 2: phones plus streams
  - 4 "phones": 120 Byte samples @ 10ms periods
    - Pes simistic IP-phone
  - Plus, 8 tcp/ip connections
    - Inf inite bandwidth sources/sinks, 1500Byte MTU
  - Phones are given highest access class
  - Tcp streams are assigned to lower classes
- Goal: observe latency and diffserv

Model 1 Examples

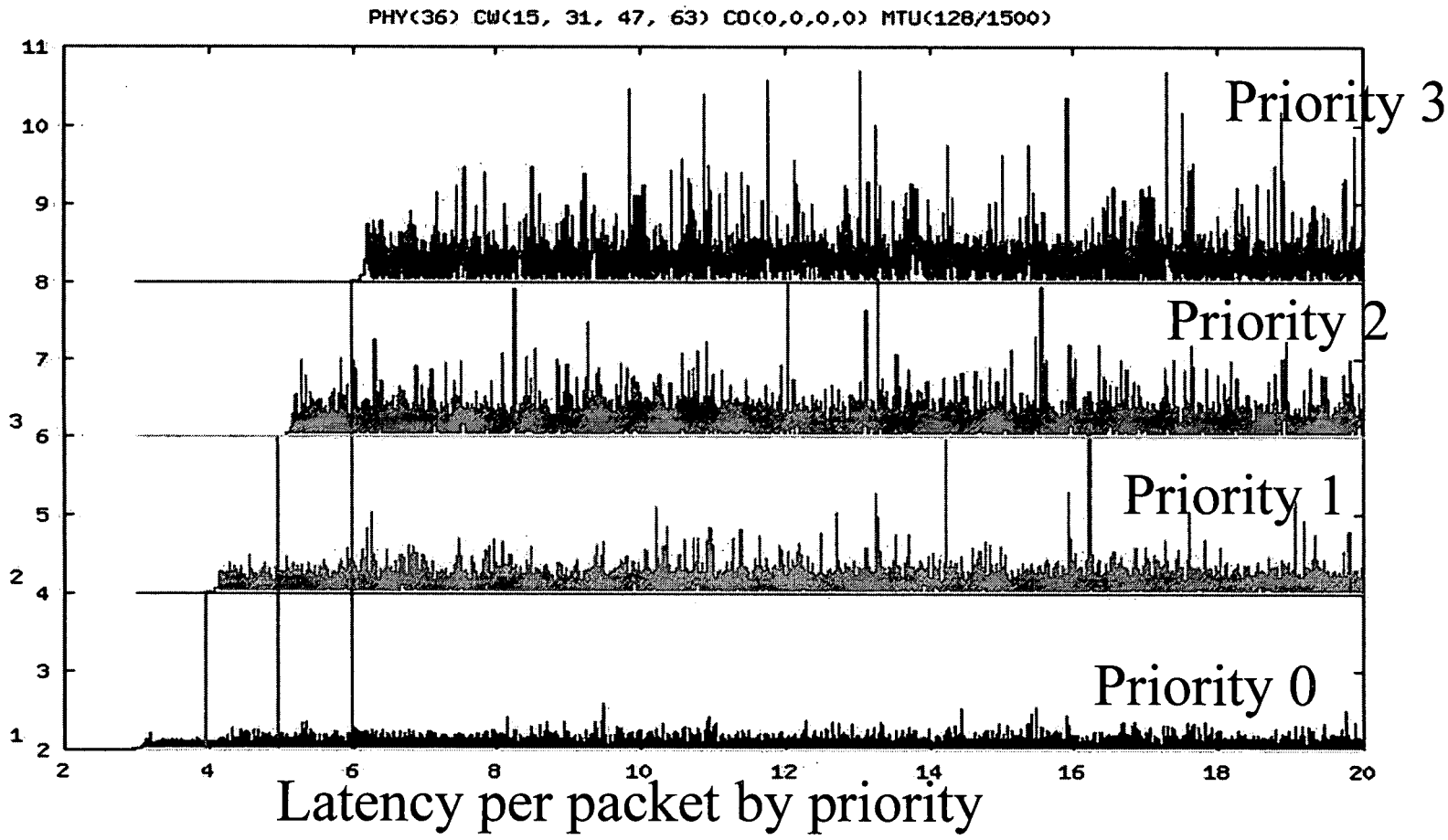
- **CWx only (CO is 0), bw, latency**
- **CO only (CW is 31): bw, latency**
- **Vary both CW and CO: bw, latency**

Latency is measured from source enqueue to Successful reception at destination MAC.

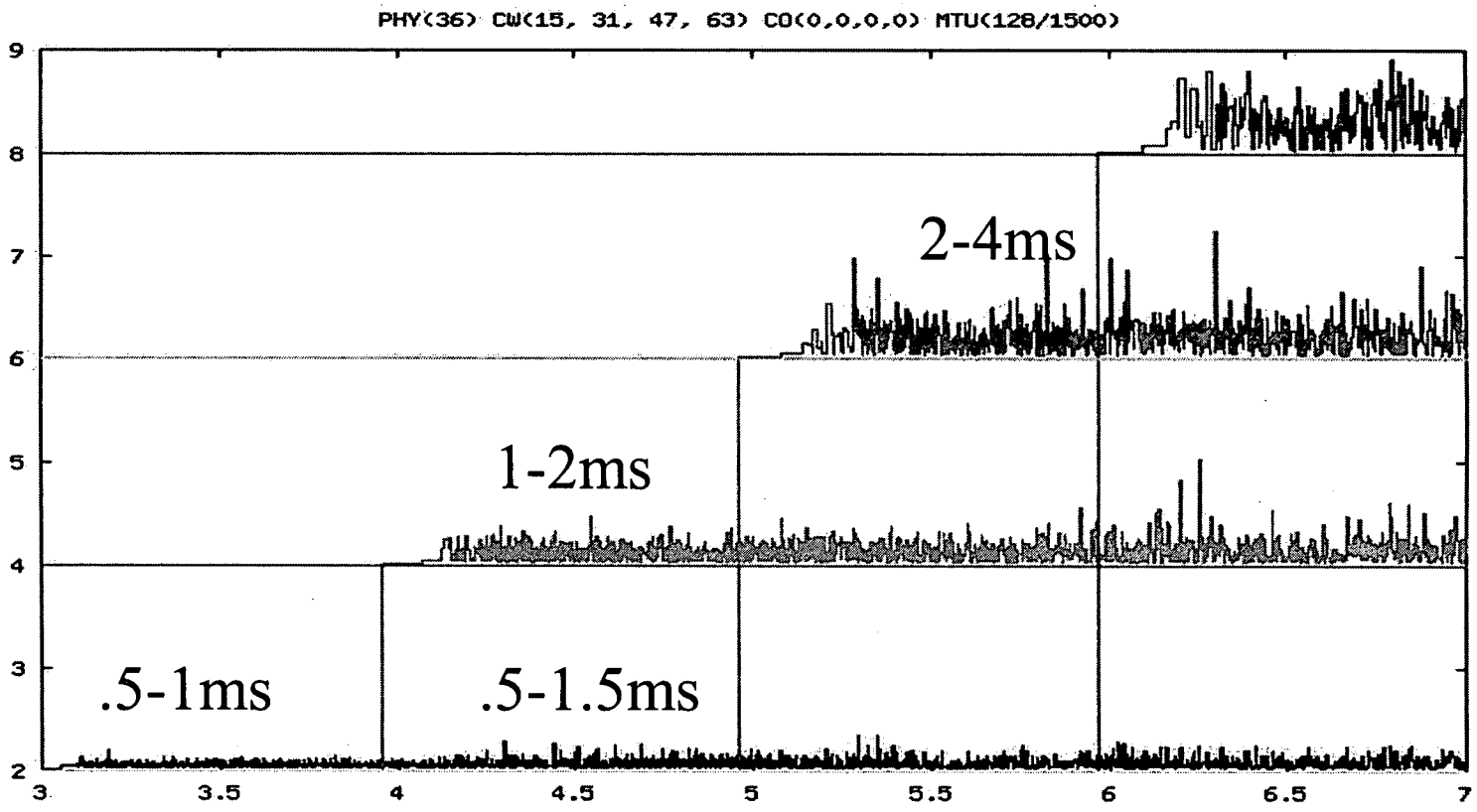
Model 1 bw (CW)


Mbytes/s
PHY(36) CW(15, 31, 47, 63) CO(0,0,0,0) MTU(128/1500)
2.5e+06
2e+06
1.5e+06
1e+06
500000
tcp 0 0
2
4
6
8
10
12
14
16
18
20
EDCF Parameters
By priority (0,1,2,3)
Begin streams on 1 sec intervals
Simulation Time (secs)

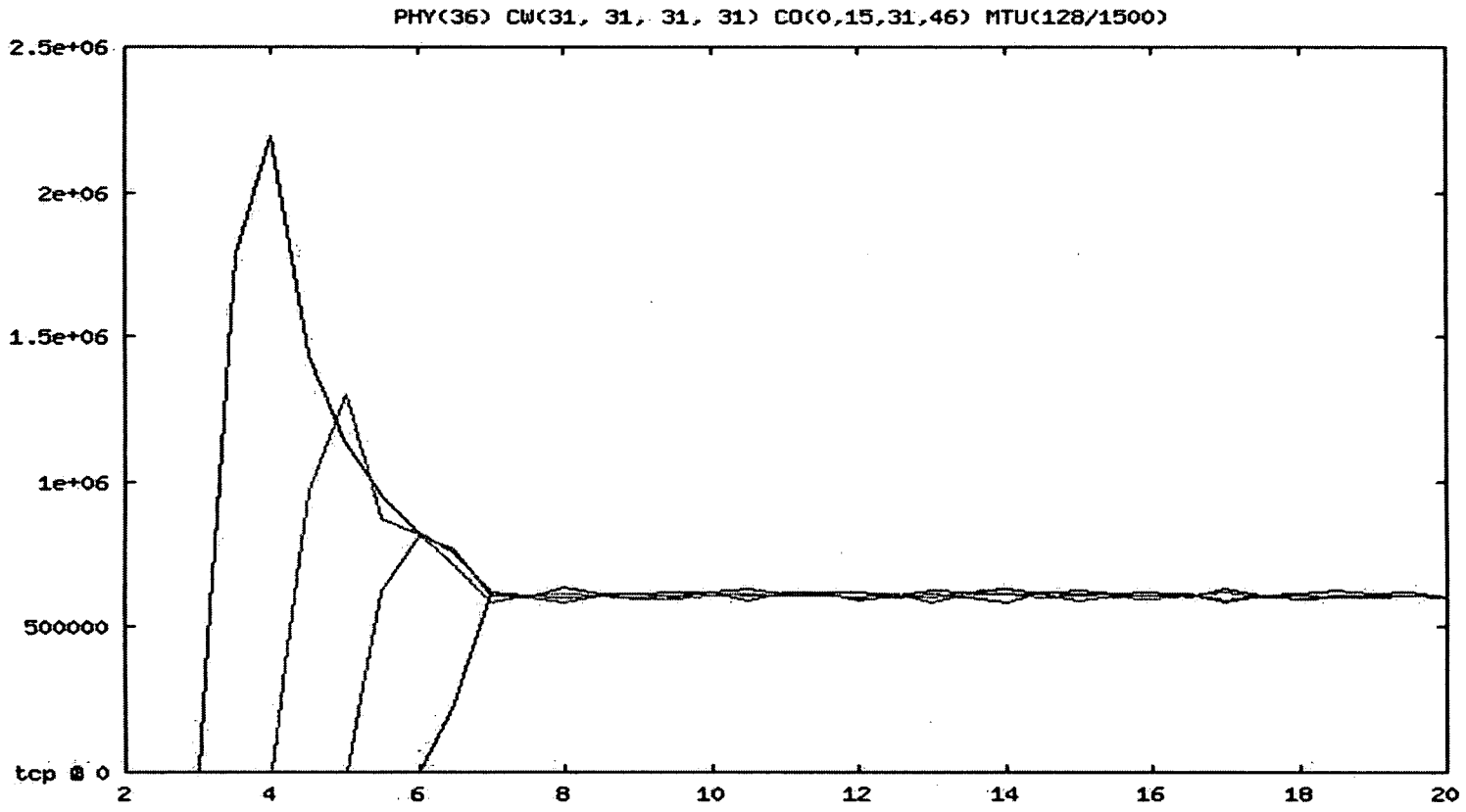
Model 1 lat (CW)



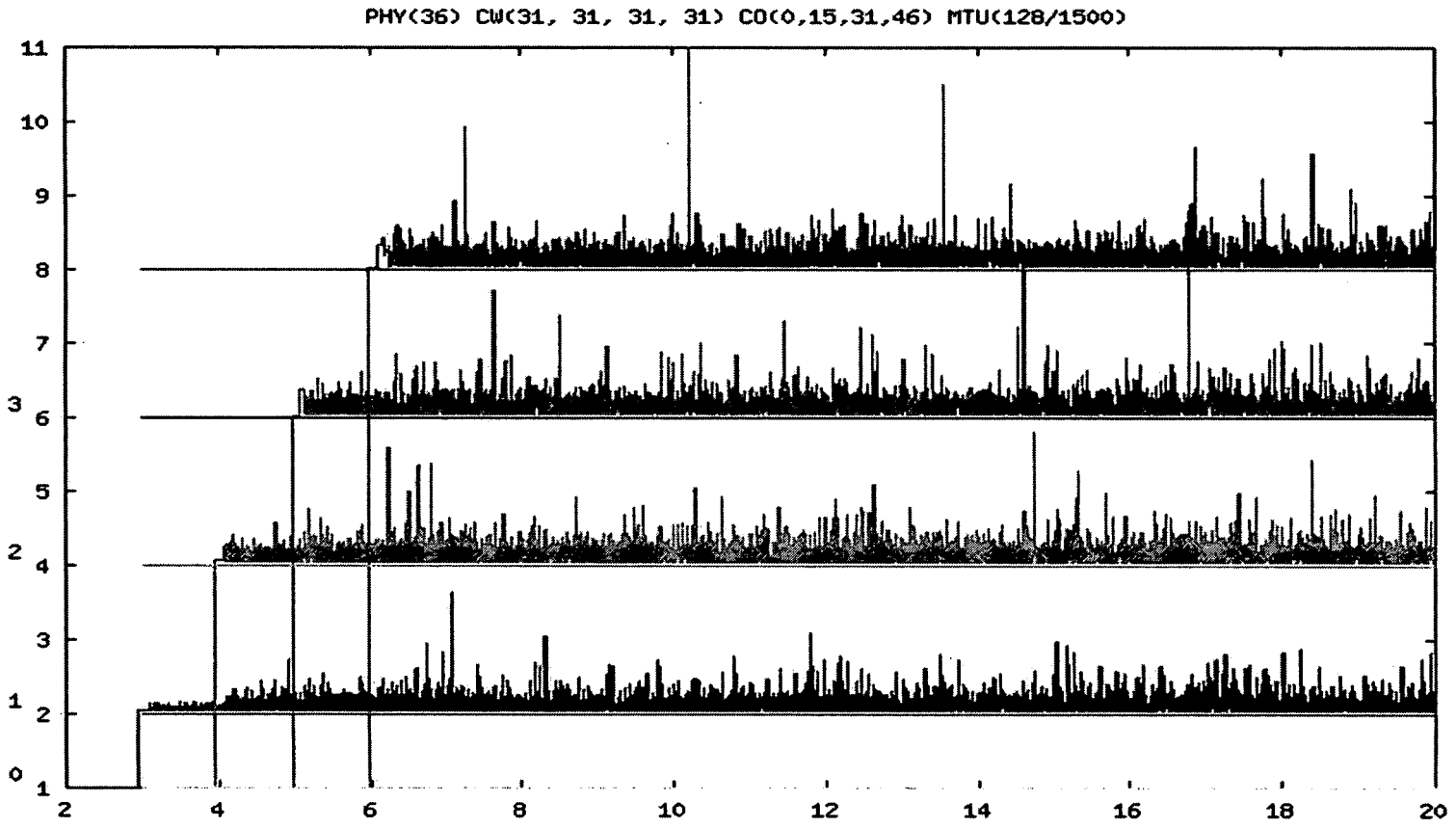
Model 1 lat (CW zoom)



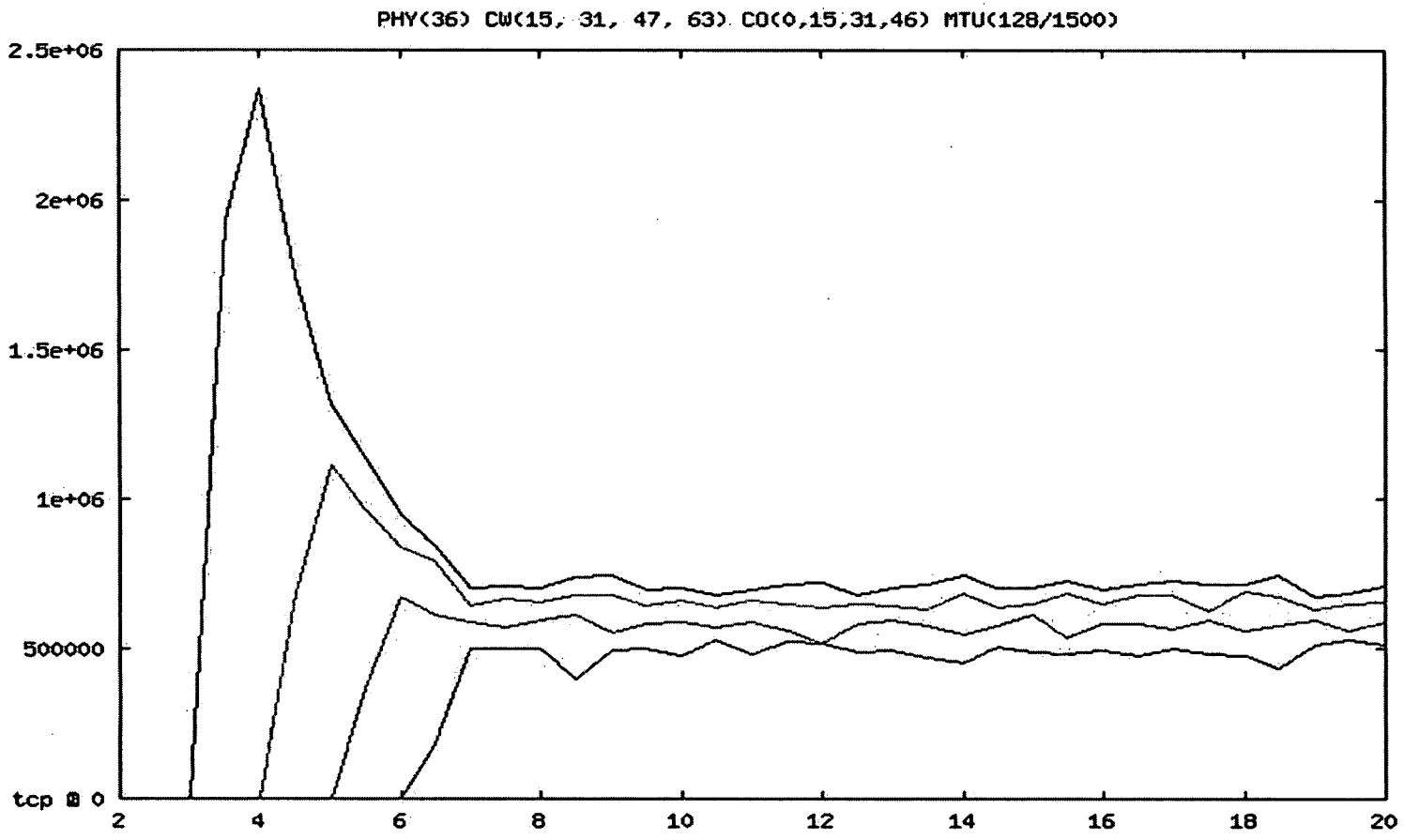
Model 1 bw (CO)


PHY(36) CW(31, 31, 31, 31) CO(0,15,31,46) MTU(128/1500)
2.5e+06
2e+06
1.5e+06
1e+06
500000
tcp @ 0
2
4
6
8
10
12
14
16
18
20

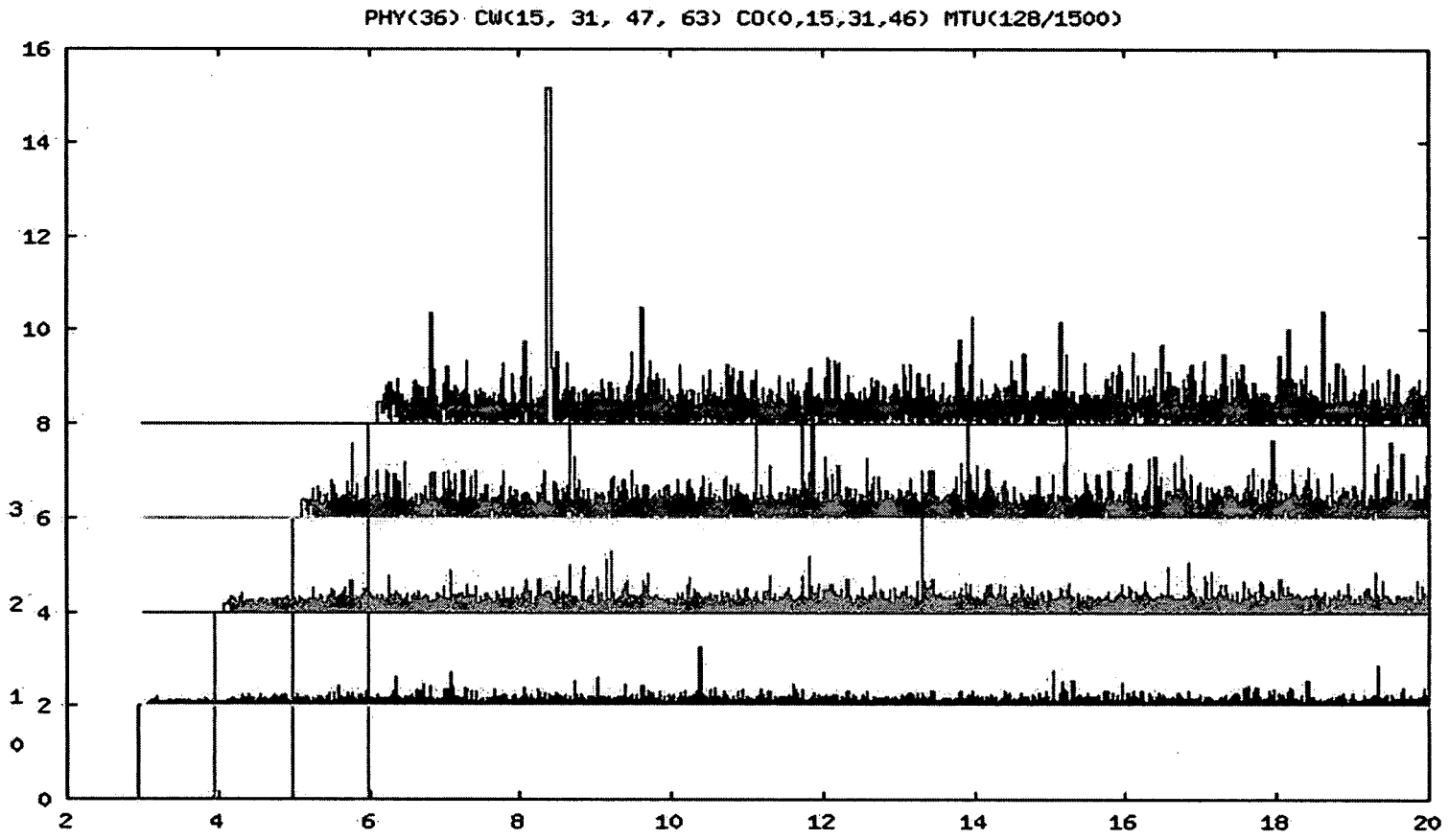
Model 1 lat (CO)



Model 1 bw (CW+CO)



Model 1 lat (CW+CO)



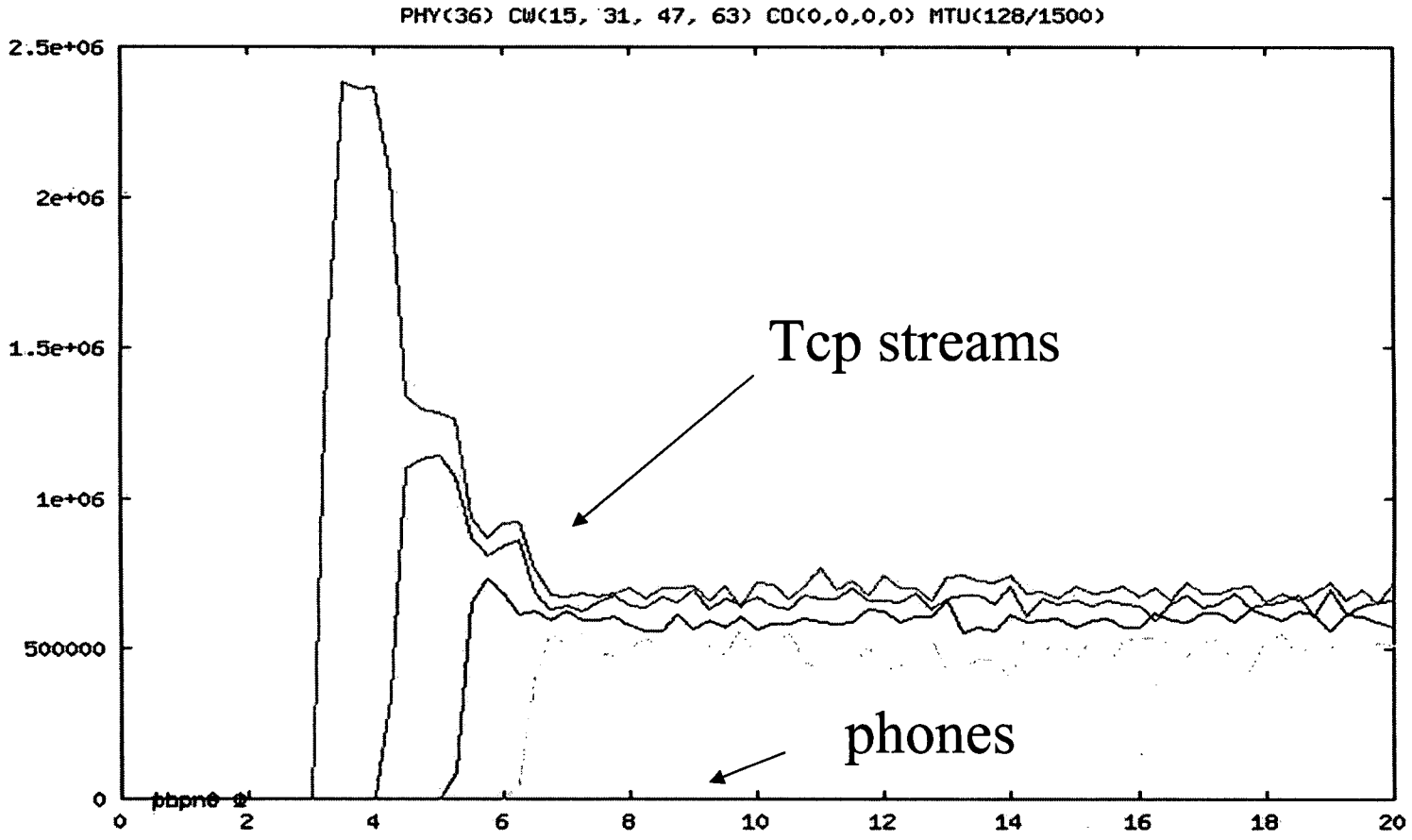
Observations

- Both CW and CO parameters control access
- Differentiated BW and LAT are possible
- Wide spread of CW/CO needed to support larger numbers of stations
  - 802.11a won't scale well with CWMin of 15

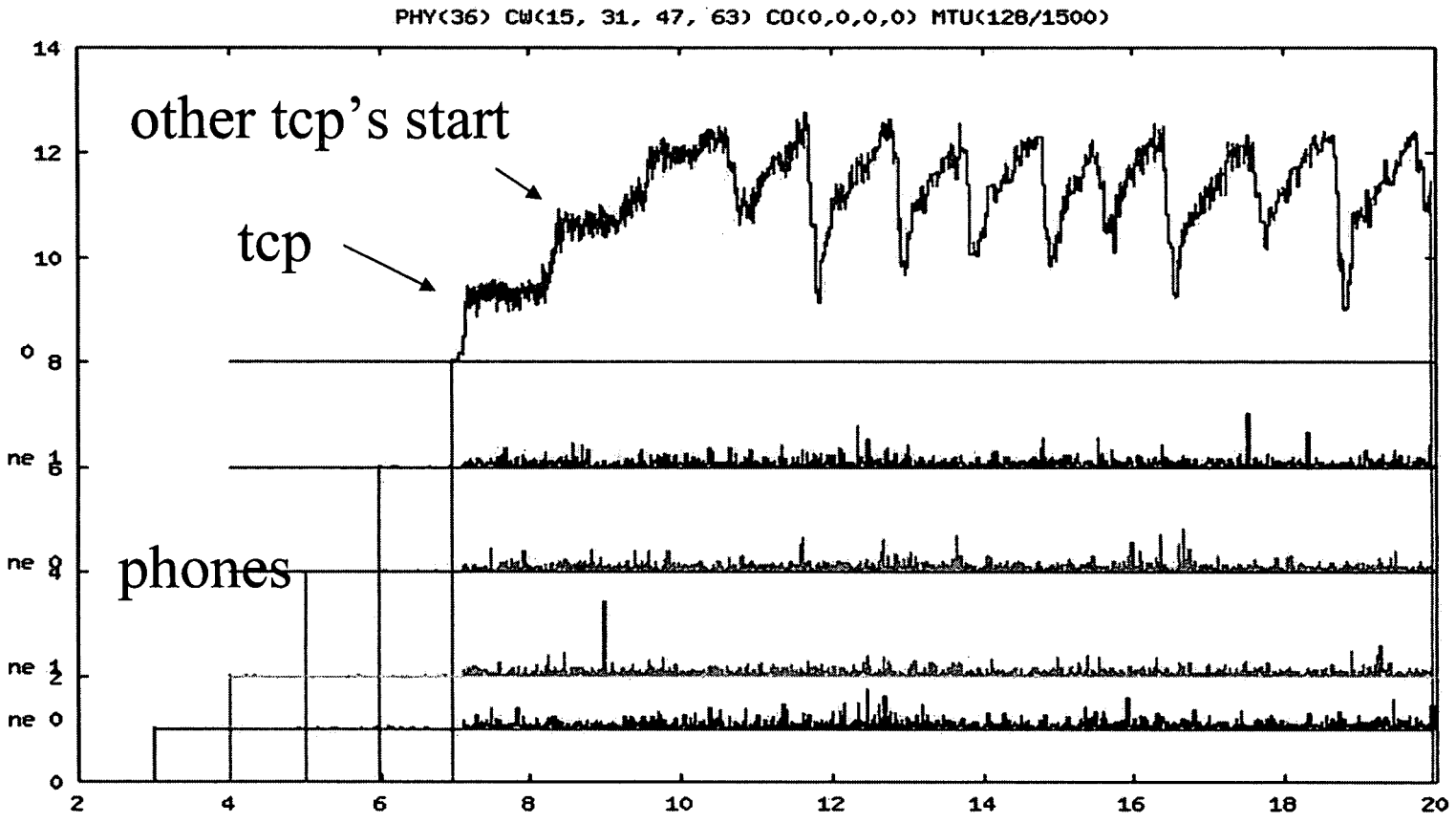
Model 2 Examples

- 4 phones, 8 tcp streams, CW only
  - Observe bw, lat
- CW+CO
  - Observer bw, lat
  - Closeup of 1 phone

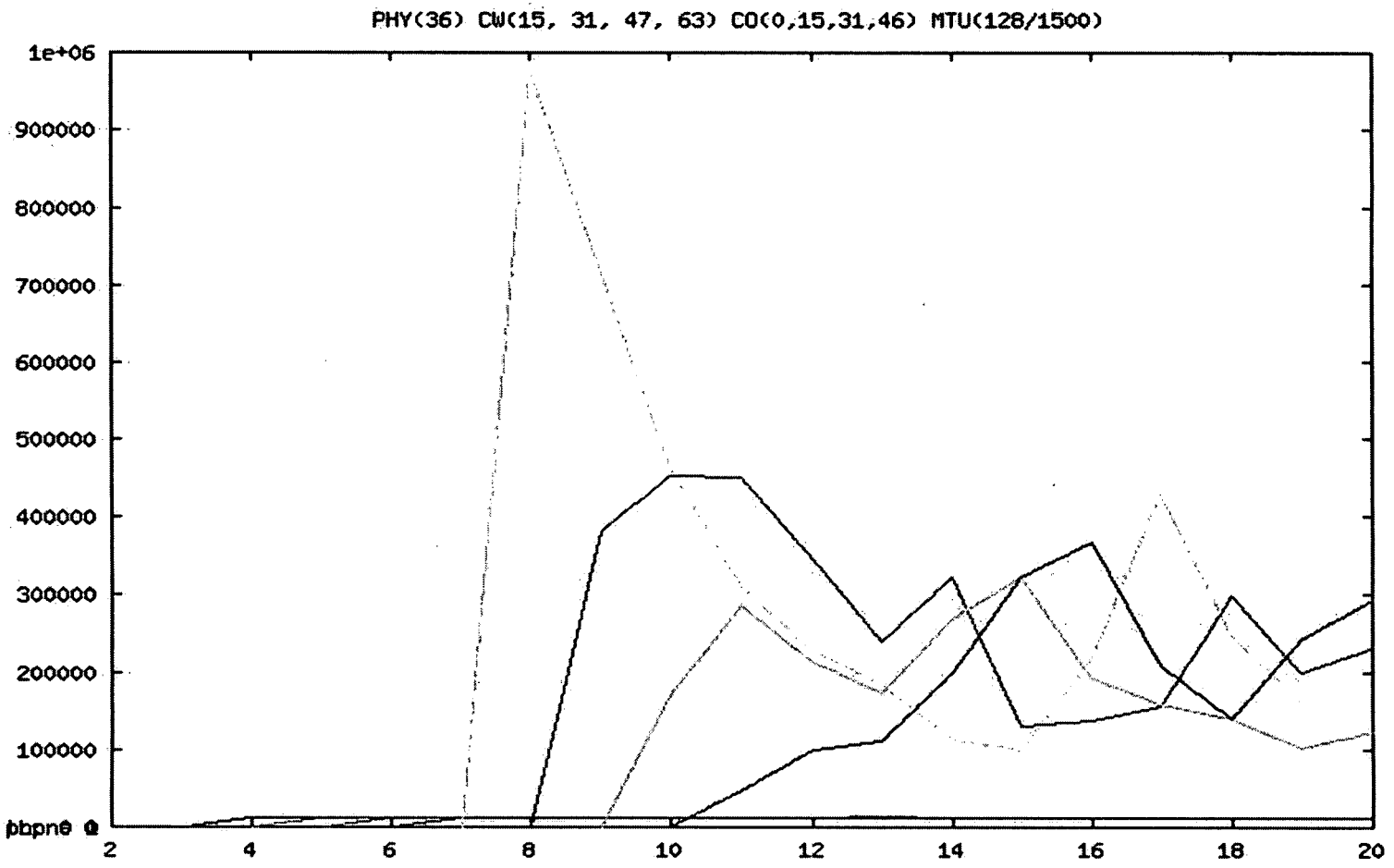
Model 2 bw (CW)


PHY(36) CW(15, 31, 47, 63) CO(0,0,0,0) MTU(128/1500)
2.5e+06
2e+06
1.5e+06
1e+06
500000
0
0
2
4
6
8
10
12
14
16
18
20
Tcp streams
phones

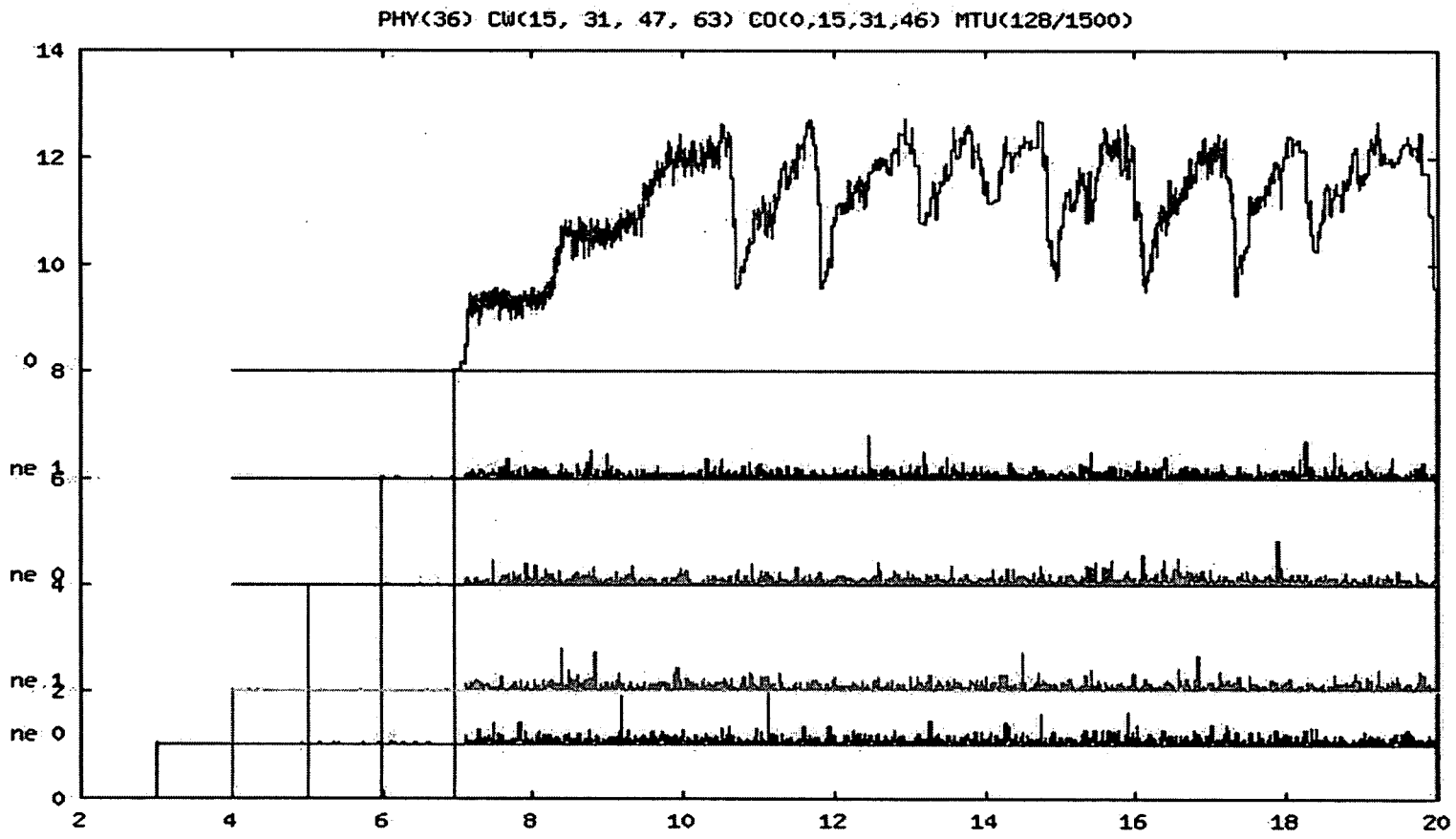
Model 2 lat (CW)



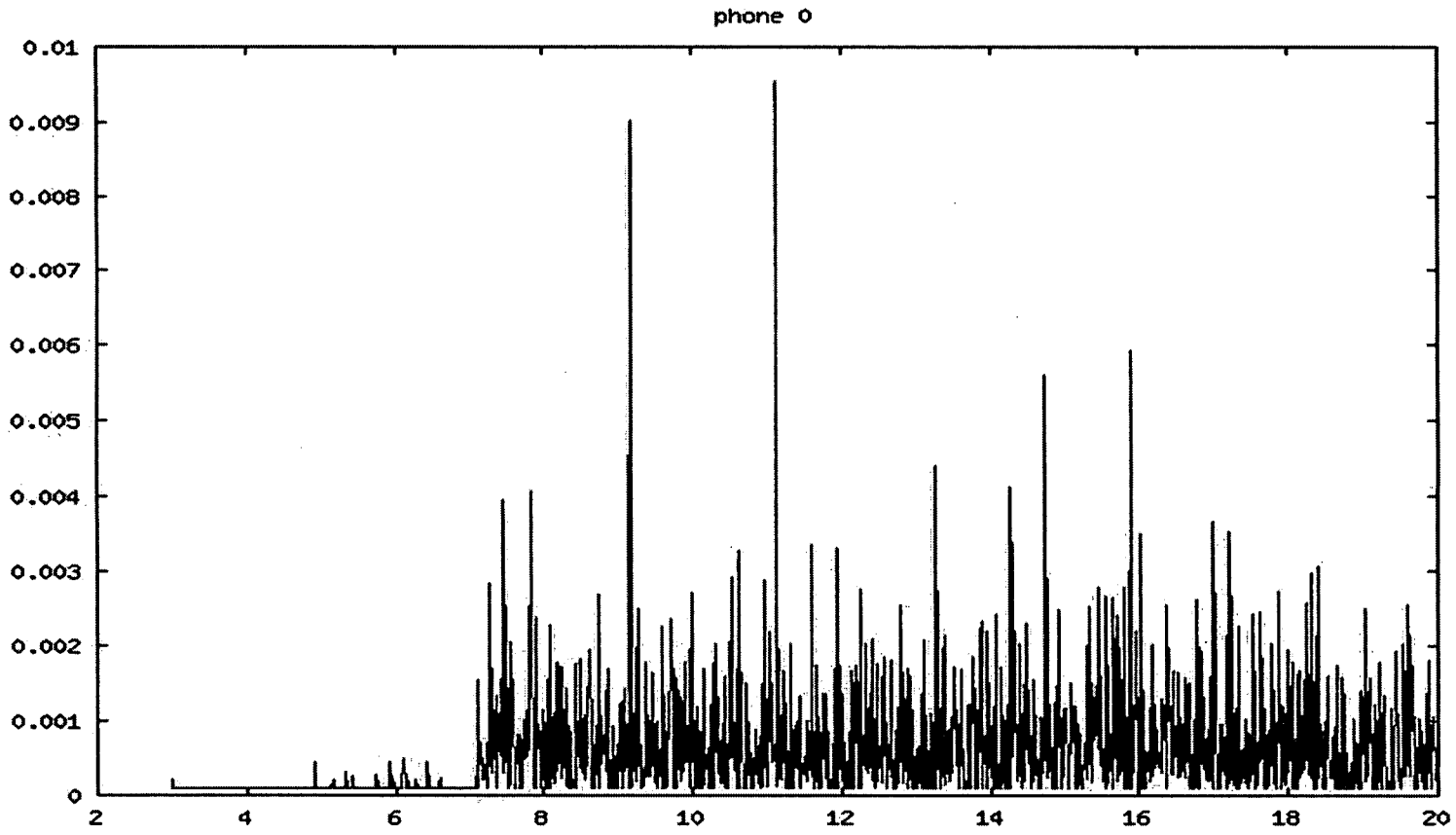
Model 2 bw (CW+CO)



Model 2 lat (CW+CO)



Model 2 lat (CW+CO)



Observations

- CW+CO provides differentiated service in more complex scenario
- Low latency for at least one class of service is possible
- Unknowns
  - Fine grain control (probably not possible)
  - Adapt to changing load (possible)
  - Exert control in overloaded state (poorly)

Next Steps

- Better scripts and automation
- Validate against hardware, traces, Opnet
- Simulate internal VDCF
- Extend current AP model
  - Forward based on access priority
  - Dynamic adjustment of CW/CO values
- Other scenarios

EXHIBIT F

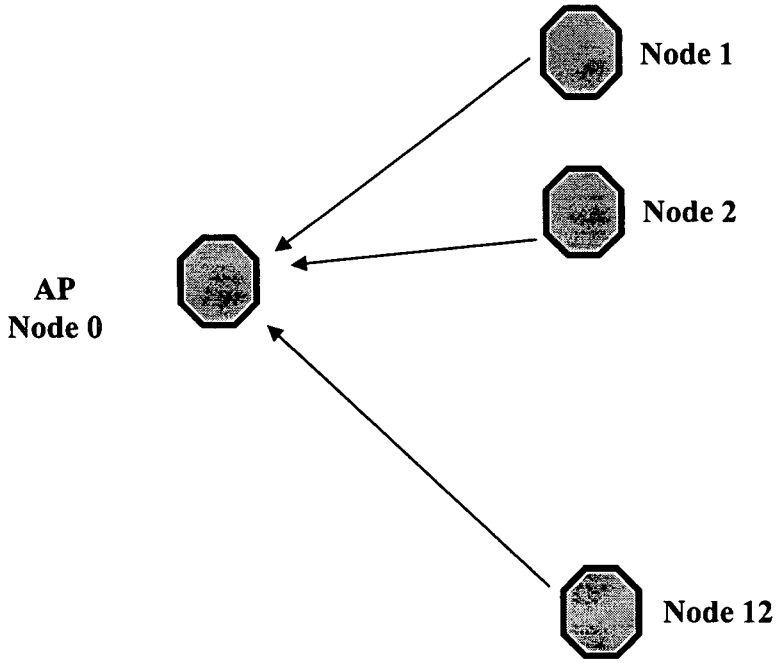
Simulation Results for QoS, pDCF, VDCF, Backoff/Retry

Greg Chesson
Aman Singla
Atheros Communications

Outline

1. Backoff/Retry/Access Methods
    1. Backoff:
        1. constant (non-increasing)
        2. exponential (doubling)
        3. hybrid (doubling only after first retry)
    2. Access Methods: DCF, pDCF
2. QoS Scenarios
    1. Pair of 1 Mbyte/s Mpeg streams plus background load
    2. Sim Group: 10/20/30-node scenario at 11 Mb/s

Backoff Scenarios



1. Simulate 3 backoff methods
   - No backoff increase on retry
   - Exponential backoff
   - Hybrid (increase backoff after first retry)
2. Simulate both pDCF and DCF
   36 Mb/s PHY, CW=15,PP=.12
3. For each combination of backoff and MAC
   - Simulate with 2 thru 12 nodes
   - 60 total runs
   - No upper layer protocol or application
   - Heavy offered load
   - Fully backlogged queues
4. Plot
   - Goodput (aggregate bandwidth)
   - Collisions
   - Channel idle time
   - Latency/Jitter

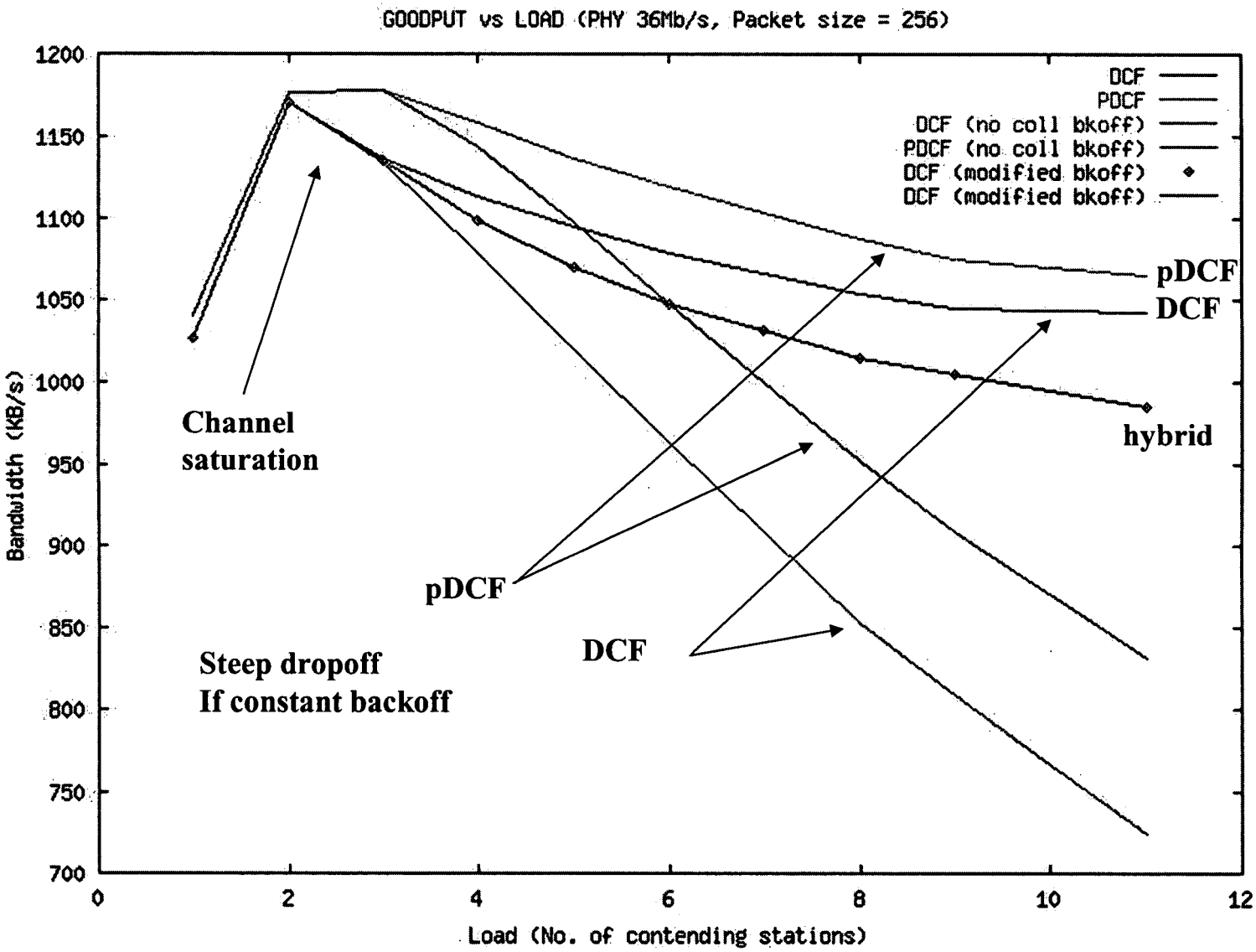
Backoff Results

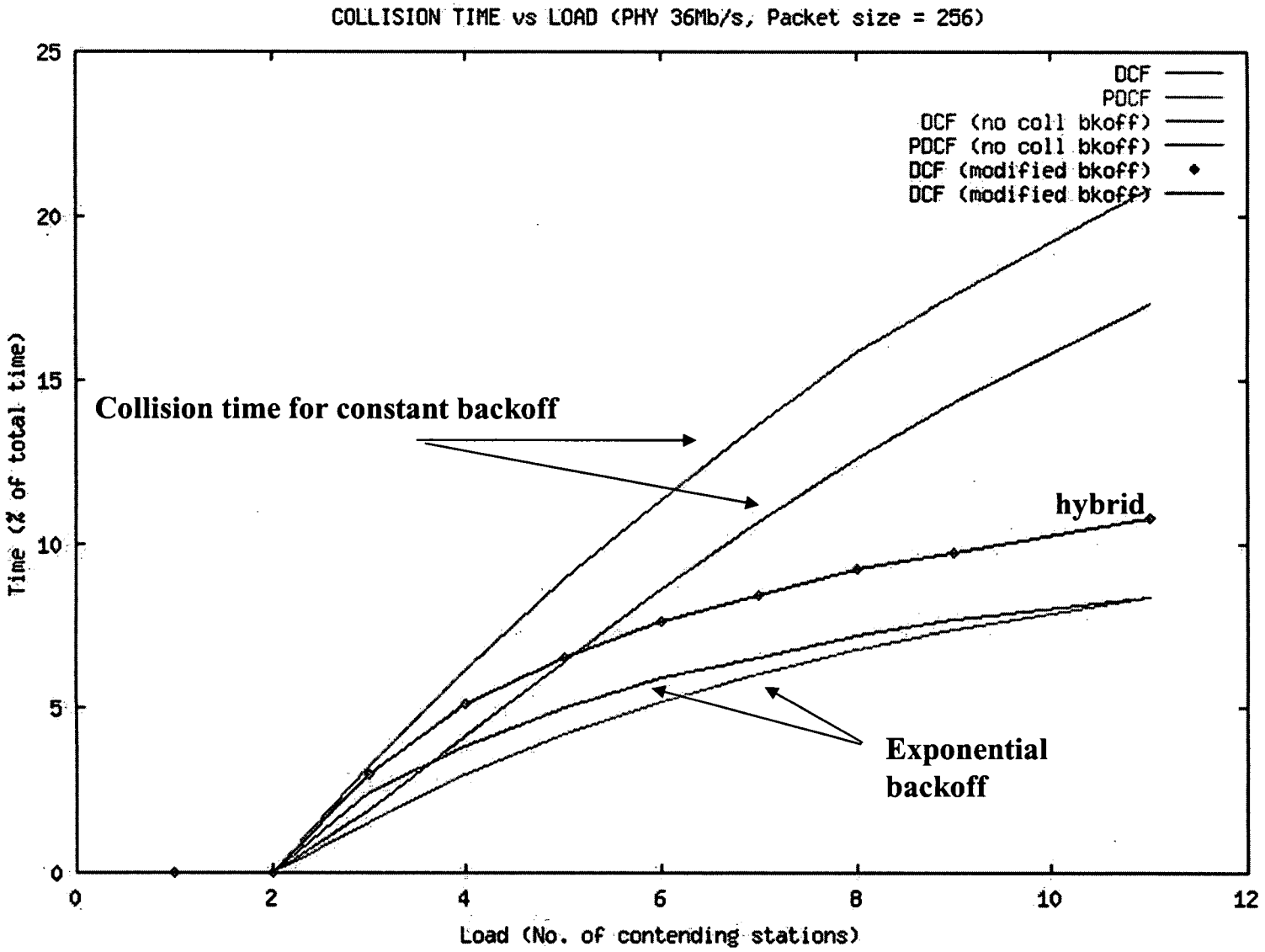
- constant backoff => high collision rate, reduced bandwidth, more congestion
- Exponential backoff => gradual degradation
- Hybrid backoff => close to exponential performance

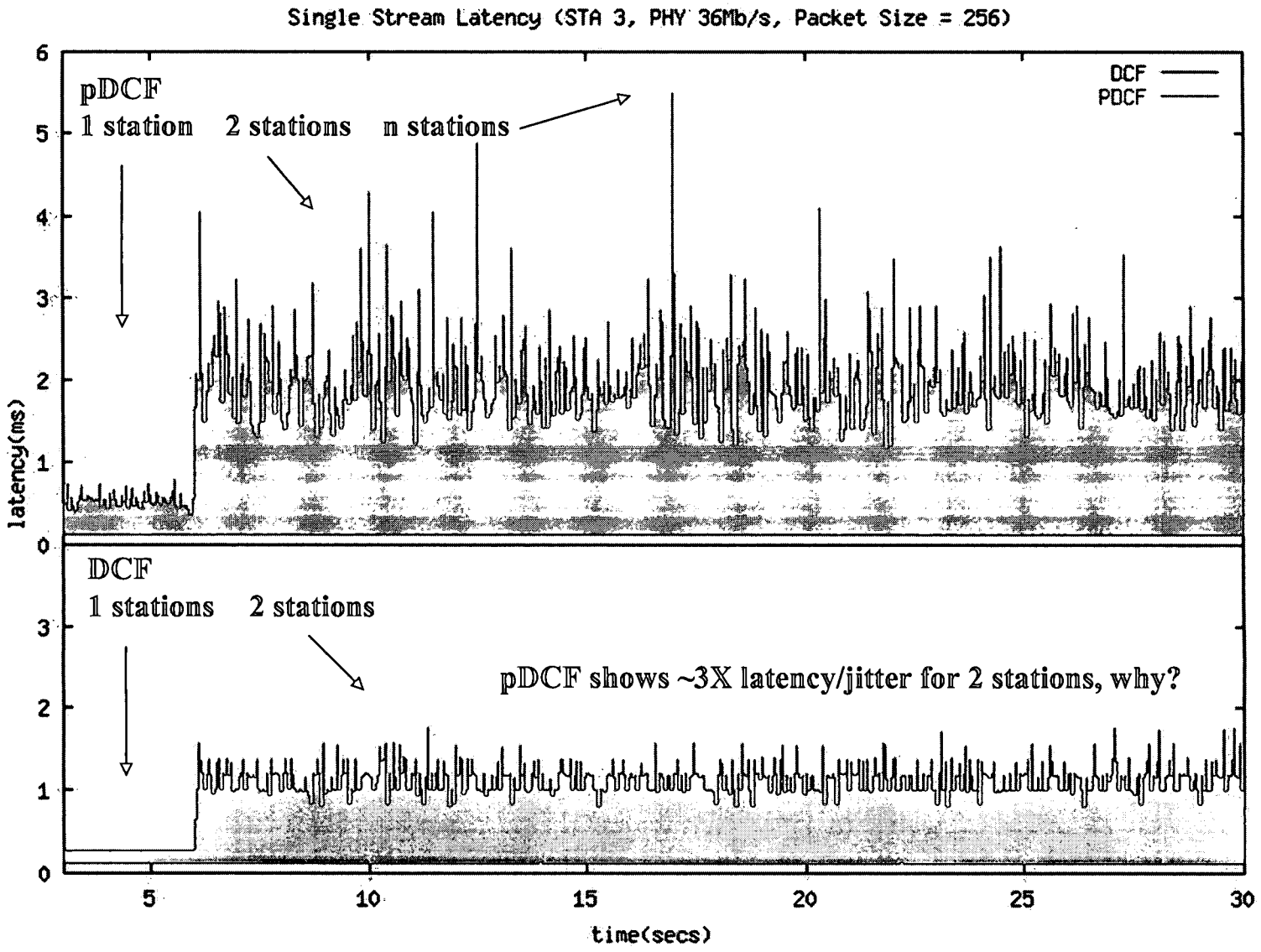
These conclusions should not be controversial as they support the conventional wisdom.

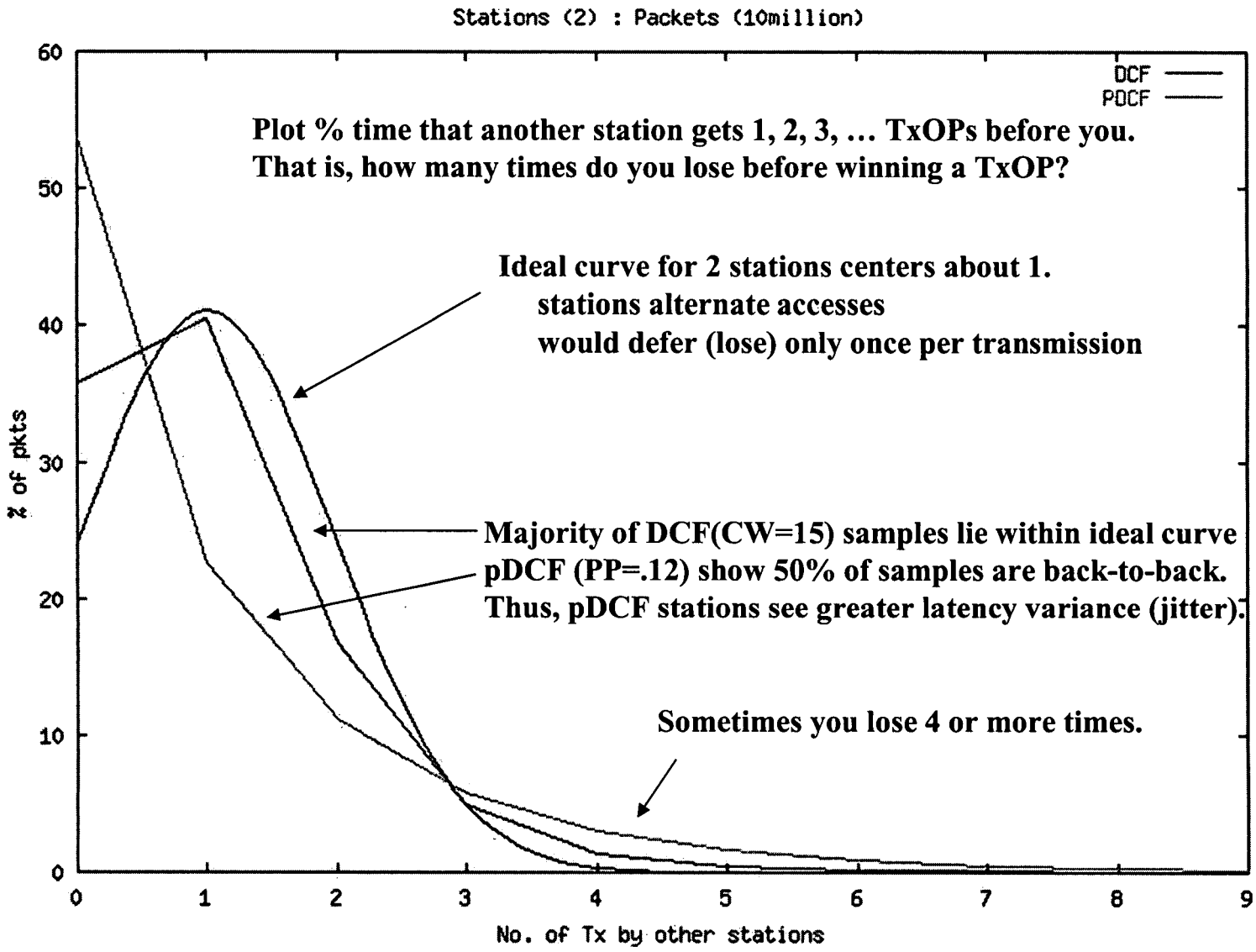
MAC Results

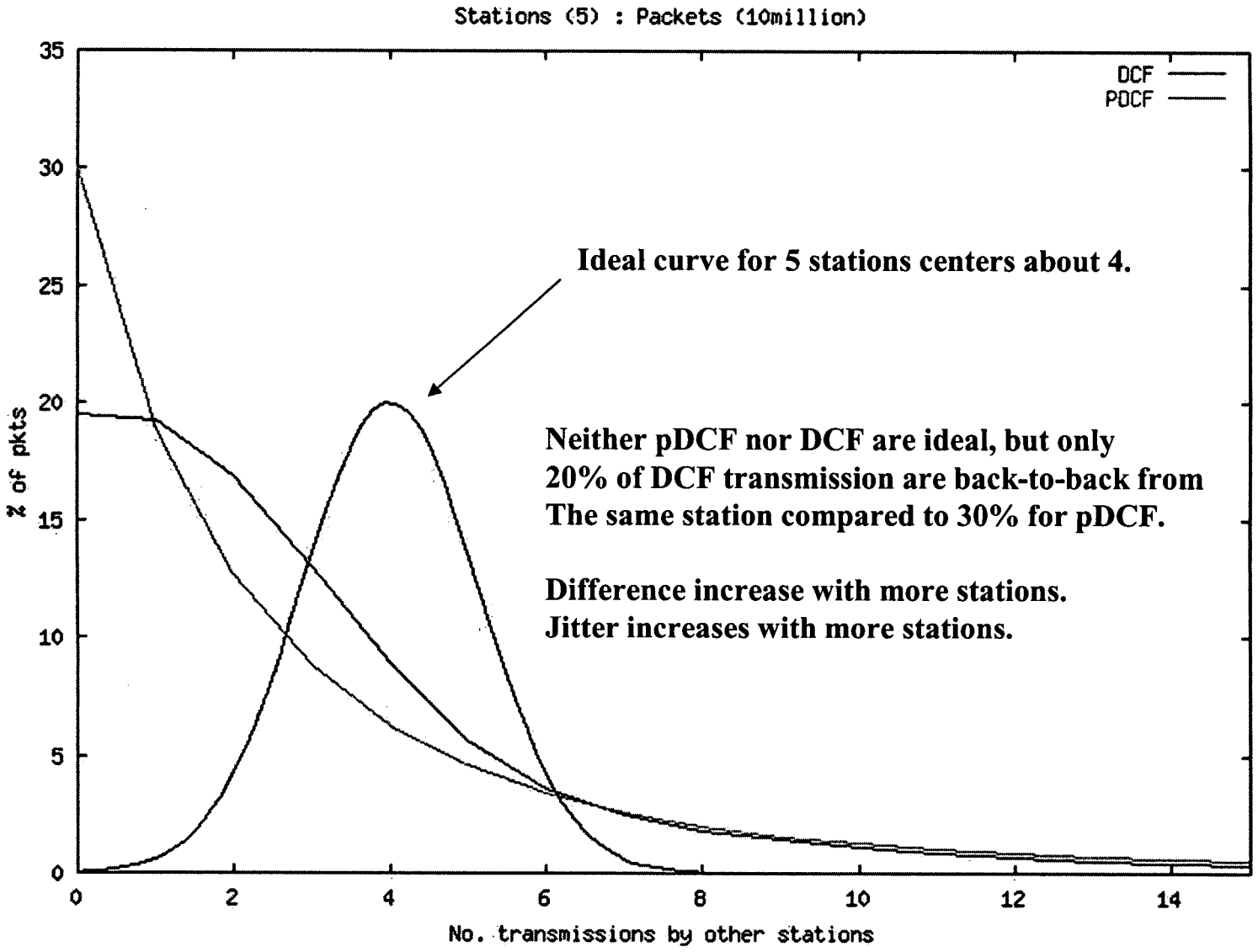
- Goodput: pDCF slightly better than DCF (~4%) because aggressive access technique improves channel efficiency at the expense of more variable channel access wait times.
- Latency/Jitter: DCF better than pDCF because TxOPs are more evenly distributed between stations (even for a 2-station scenario!).
- Explanation: study expected MAC access delay times per station.


GOODPUT vs LOAD (PHY 36Mb/s, Packet size = 256)
Bandwidth (KB/s)
Load (No. of contending stations)
1200
1150
1100
1050
1000
950
900
850
800
750
700
0
2
4
6
8
10
12
DCF
PDCF
DCF (no coll bkoff)
PDCF (no coll bkoff)
DCF (modified bkoff)
DCF (modified bkoff)
pDCF
DCF
hybrid
Channel saturation
pDCF
DCF
Steep dropoff
If constant backoff


COLLISION TIME vs LOAD (PHY 36Mb/s, Packet size = 256)
DCF
PDCF
DCF (no coll bkoff)
PDCF (no coll bkoff)
DCF (modified bkoff)
DCF (modified bkoff)
Collision time for constant backoff
hybrid
Exponential backoff
Time (% of total time)
Load (No. of contending stations)
0
5
10
15
20
25
0
2
4
6
8
10
12


Single Stream Latency (STA 3, PHY 36Mb/s, Packet Size = 256)
pDCF
1 station
2 stations
n stations
DCF
PDCF
DCF
1 stations
2 stations
pDCF shows ~3X latency/jitter for 2 stations, why?
latency(ms)
time(secs)
0
1
2
3
4
5
6
5
10
15
20
25
30


Stations (2) : Packets (10million)
DCF
PDCF
Plot % time that another station gets 1, 2, 3, ... TxOPs before you.
That is, how many times do you lose before winning a TxOP?
Ideal curve for 2 stations centers about 1.
stations alternate accesses
would defer (lose) only once per transmission
Majority of DCF(CW=15) samples lie within ideal curve
pDCF (PP=.12) show 50% of samples are back-to-back.
Thus, pDCF stations see greater latency variance (jitter).
Sometimes you lose 4 or more times.
% of pkts
No. of Tx by other stations
0
10
20
30
40
50
60
0
1
2
3
4
5
6
7
8
9

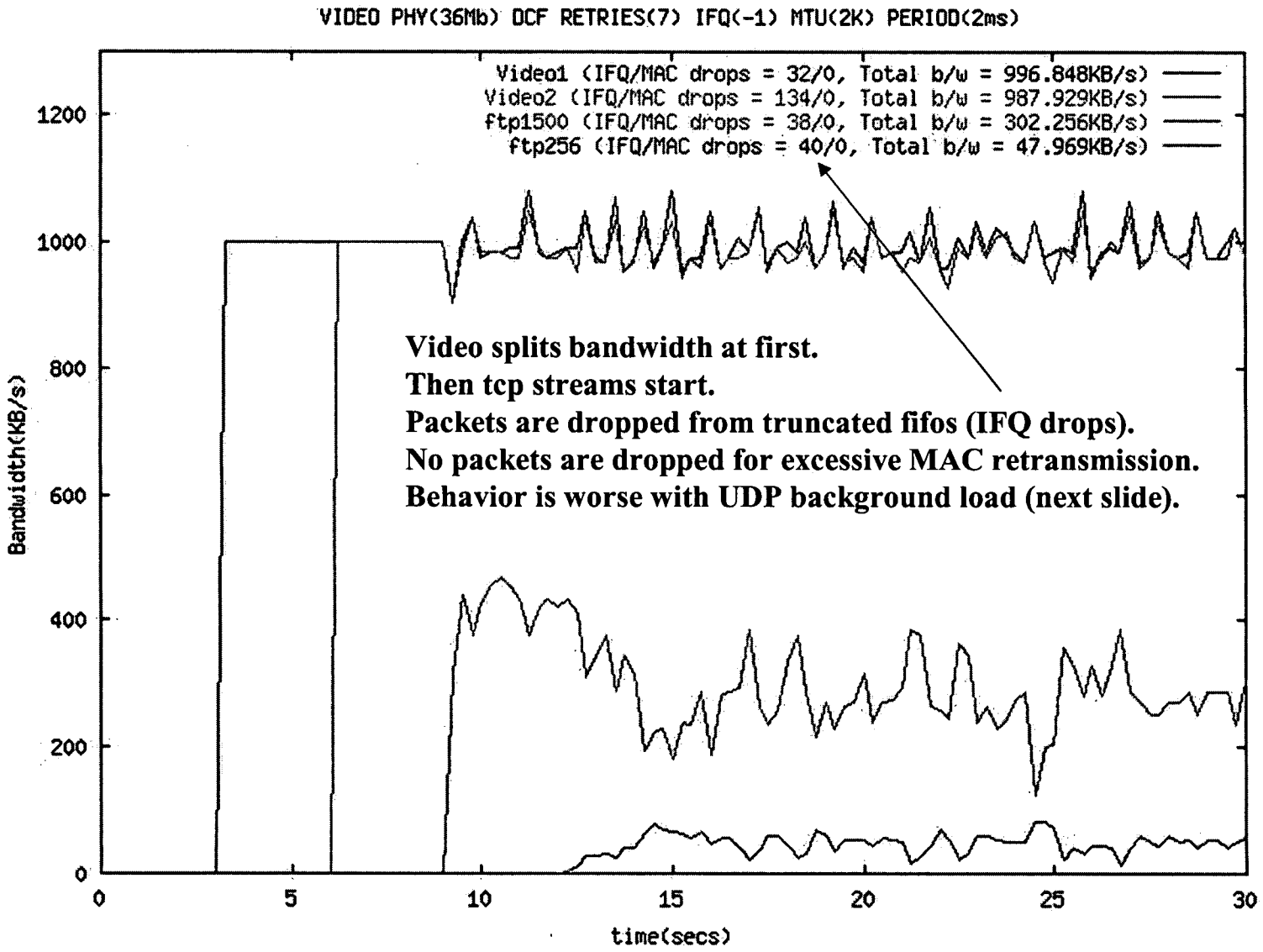

Stations (5) : Packets (10million)
DCF
PDCF
% of pkts
No. transmissions by other stations
0
5
10
15
20
25
30
35
0
2
4
6
8
10
12
14
Ideal curve for 5 stations centers about 4.
Neither pDCF nor DCF are ideal, but only
20% of DCF transmission are back-to-back from
The same station compared to 30% for pDCF.
Difference increase with more stations.
Jitter increases with more stations.

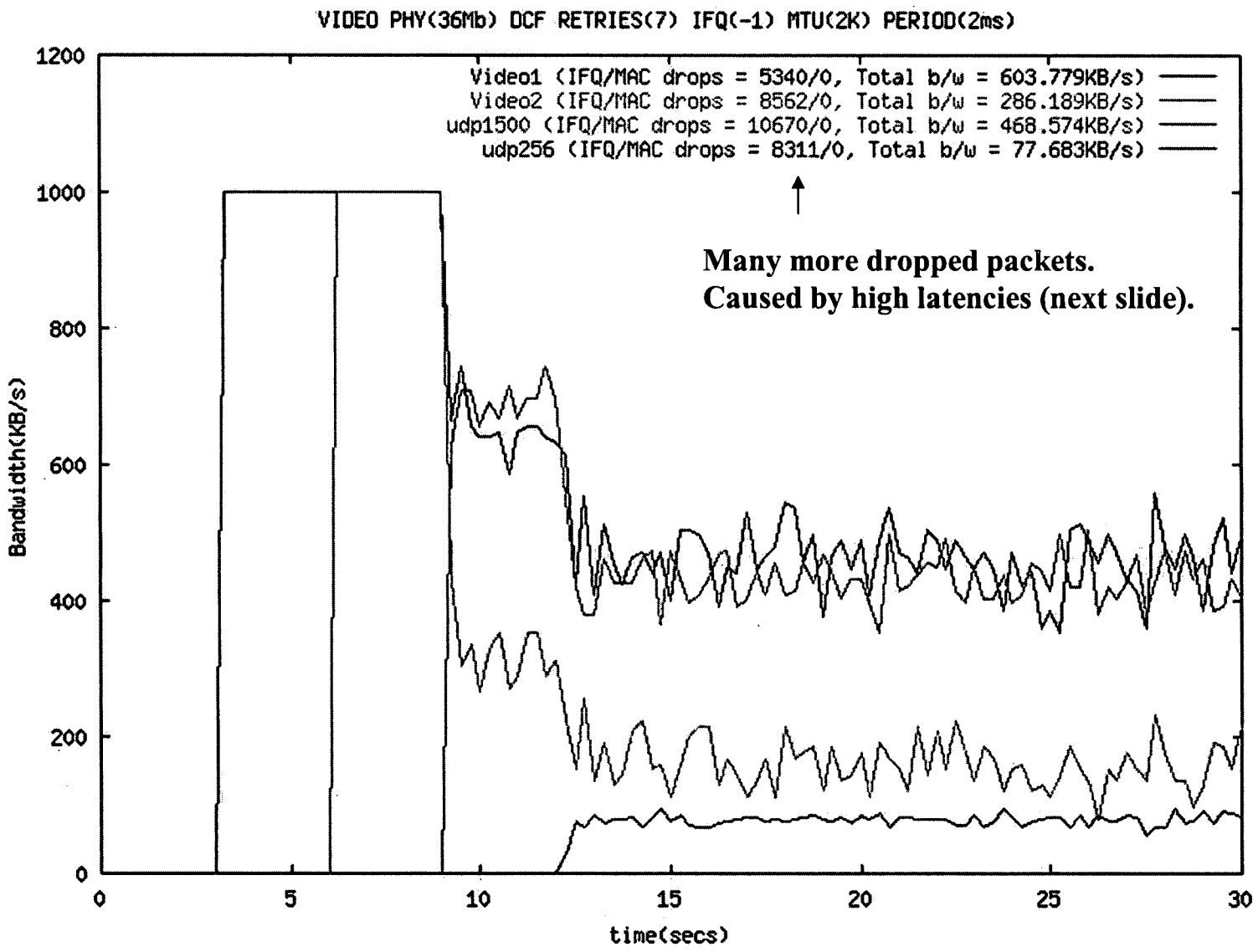
Conclusions

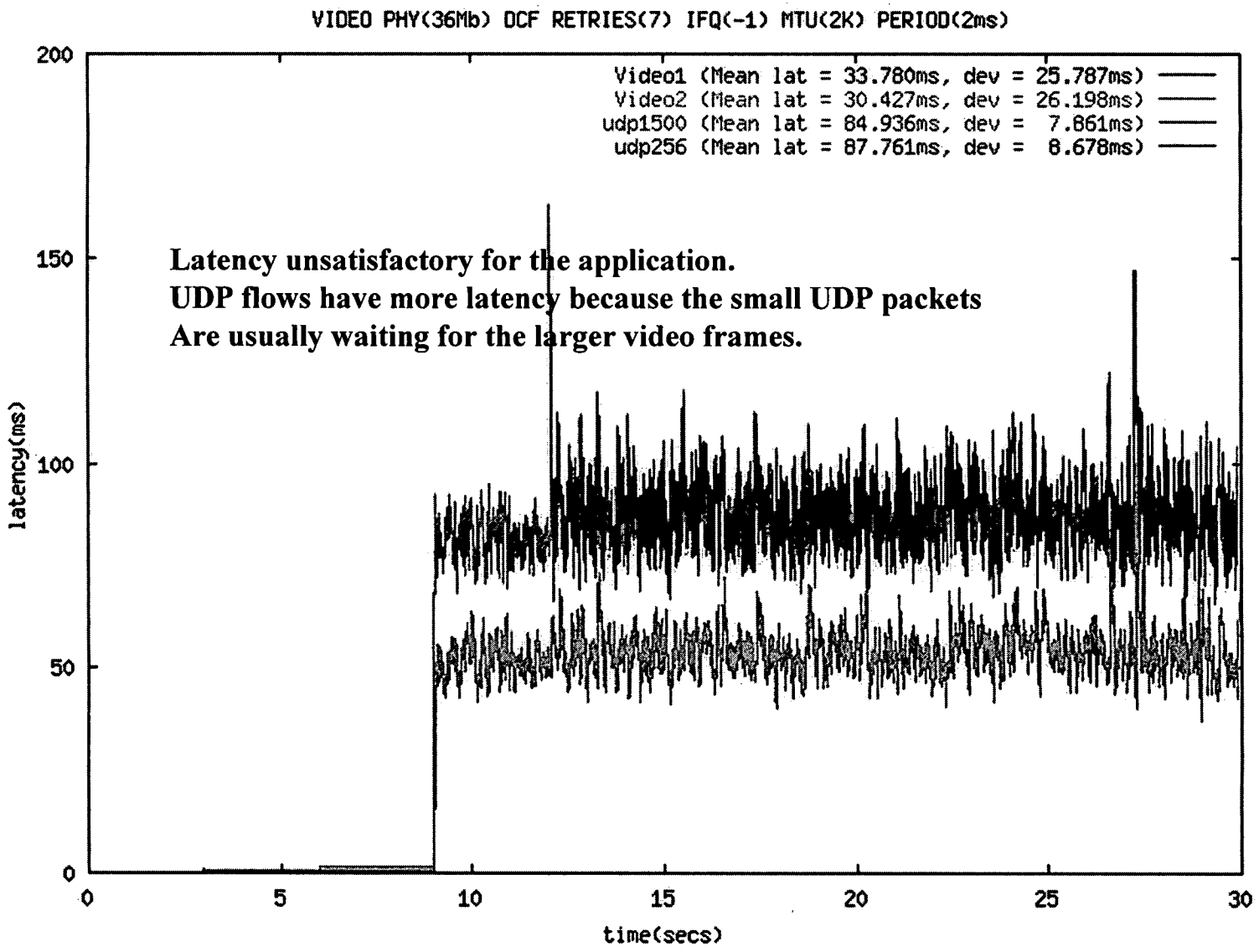
1. Exponential backoff essential for robustness
2. DCF(CW) equals pDCF(PP=2/(CW+1))
   - pDCF achieves slightly more bandwidth
   - pDCF introduces much more jitter
3. pDCF(adaptive PP) equals DCF(adaptive CW)
   - Set CW=2/PP – 1
   - After adaptation: same bandwidth/jitter differences
   - No compelling reason to change basic access method

Qos Simulations

- Video scenario: 2 1-Mbyte/sec streams plus load
  - AP sends to 2 stations
  - 4 additional stations generating high load
    - TCP load (tcp data and tcp acks forward thru AP)
    - unconstrained UDP load (AP acts as infinite sink)
- Plot bandwidth, latency, packet drops for
  - DCF
  - AP with packet scheduler (only)
  - VDCF

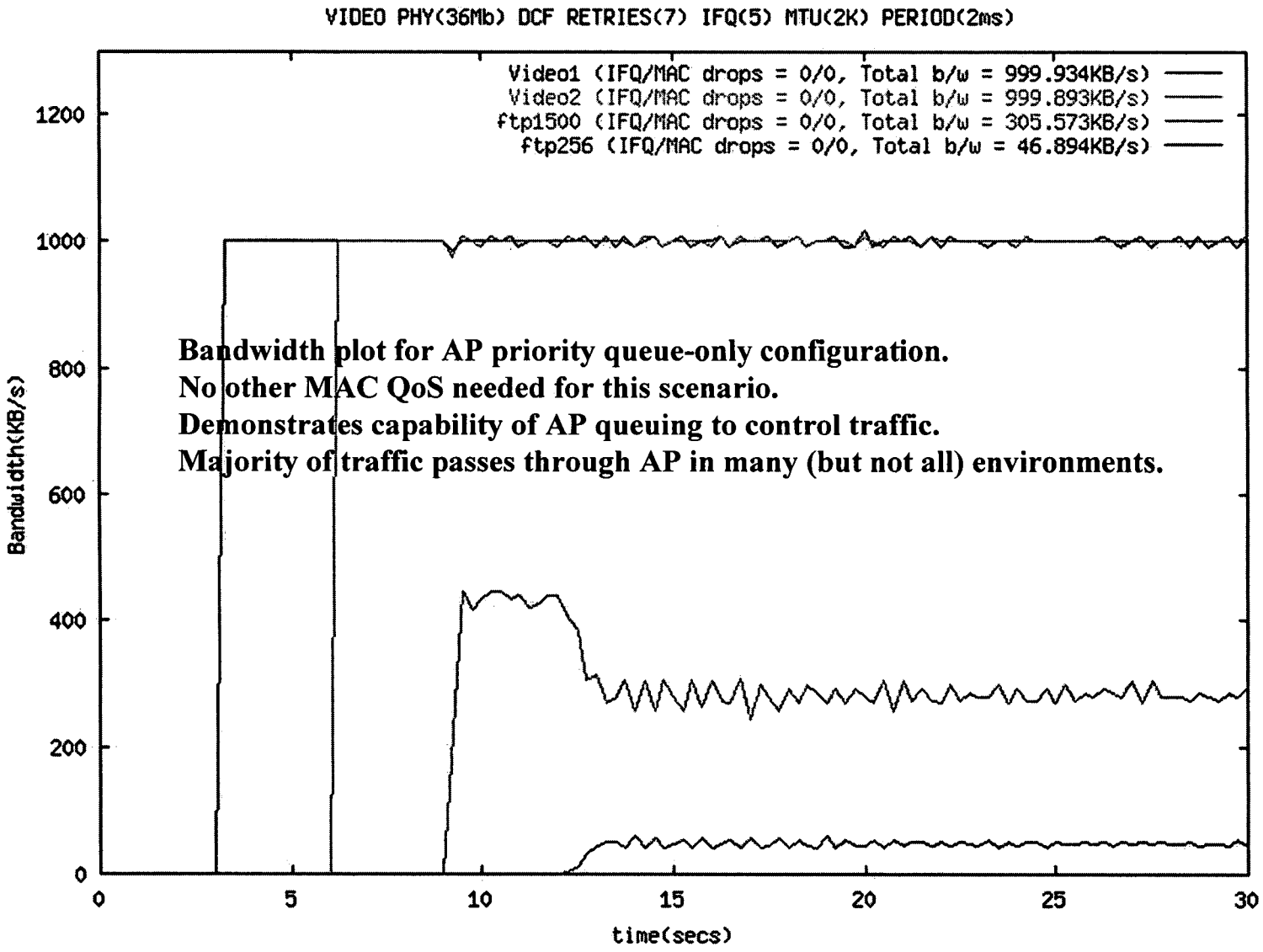

VIDEO PHY(36Mb) DCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (IFQ/MAC drops = 32/0, Total b/w = 996.848KB/s)
Video2 (IFQ/MAC drops = 134/0, Total b/w = 987.929KB/s)
ftp1500 (IFQ/MAC drops = 38/0, Total b/w = 302.256KB/s)
ftp256 (IFQ/MAC drops = 40/0, Total b/w = 47.969KB/s)
Video splits bandwidth at first.
Then tcp streams start.
Packets are dropped from truncated fifos (IFQ drops).
No packets are dropped for excessive MAC retransmission.
Behavior is worse with UDP background load (next slide).
Bandwidth(KB/s)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30
time(secs)

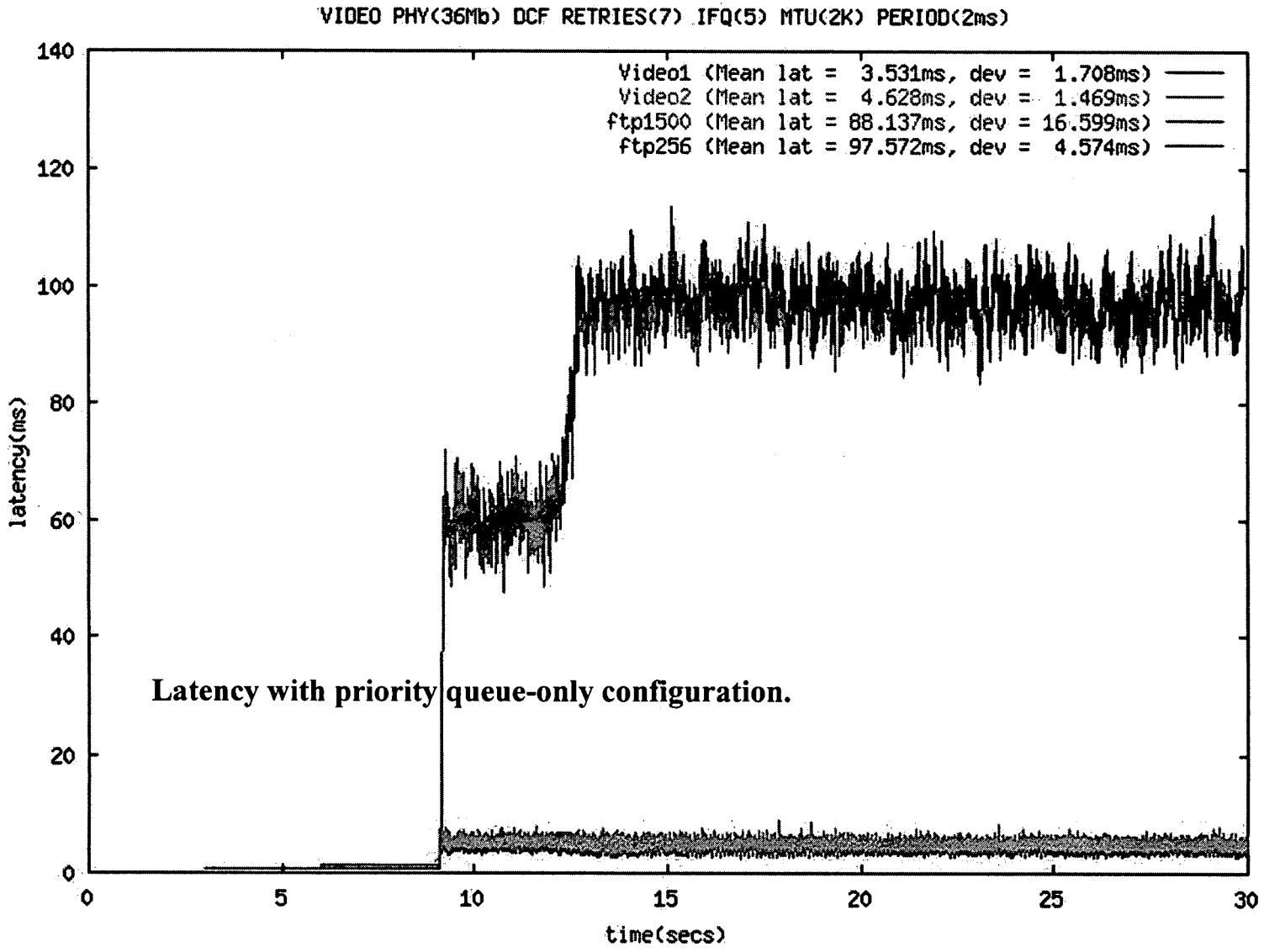

VIDEO PHY(36Mb) DCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (IFQ/MAC drops = 5340/0, Total b/w = 603.779KB/s)
Video2 (IFQ/MAC drops = 8562/0, Total b/w = 286.189KB/s)
udp1500 (IFQ/MAC drops = 10670/0, Total b/w = 468.574KB/s)
udp256 (IFQ/MAC drops = 8311/0, Total b/w = 77.683KB/s)
Many more dropped packets.
Caused by high latencies (next slide).
Bandwidth(KB/s)
time(secs)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30


VIDEO PHY(36Mb) DCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (Mean lat = 33.780ms, dev = 25.787ms)
Video2 (Mean lat = 30.427ms, dev = 26.198ms)
udp1500 (Mean lat = 84.936ms, dev = 7.861ms)
udp256 (Mean lat = 87.761ms, dev = 8.678ms)
Latency unsatisfactory for the application.
UDP flows have more latency because the small UDP packets
Are usually waiting for the larger video frames.
latency(ms)
time(secs)
0
50
100
150
200
0
5
10
15
20
25
30

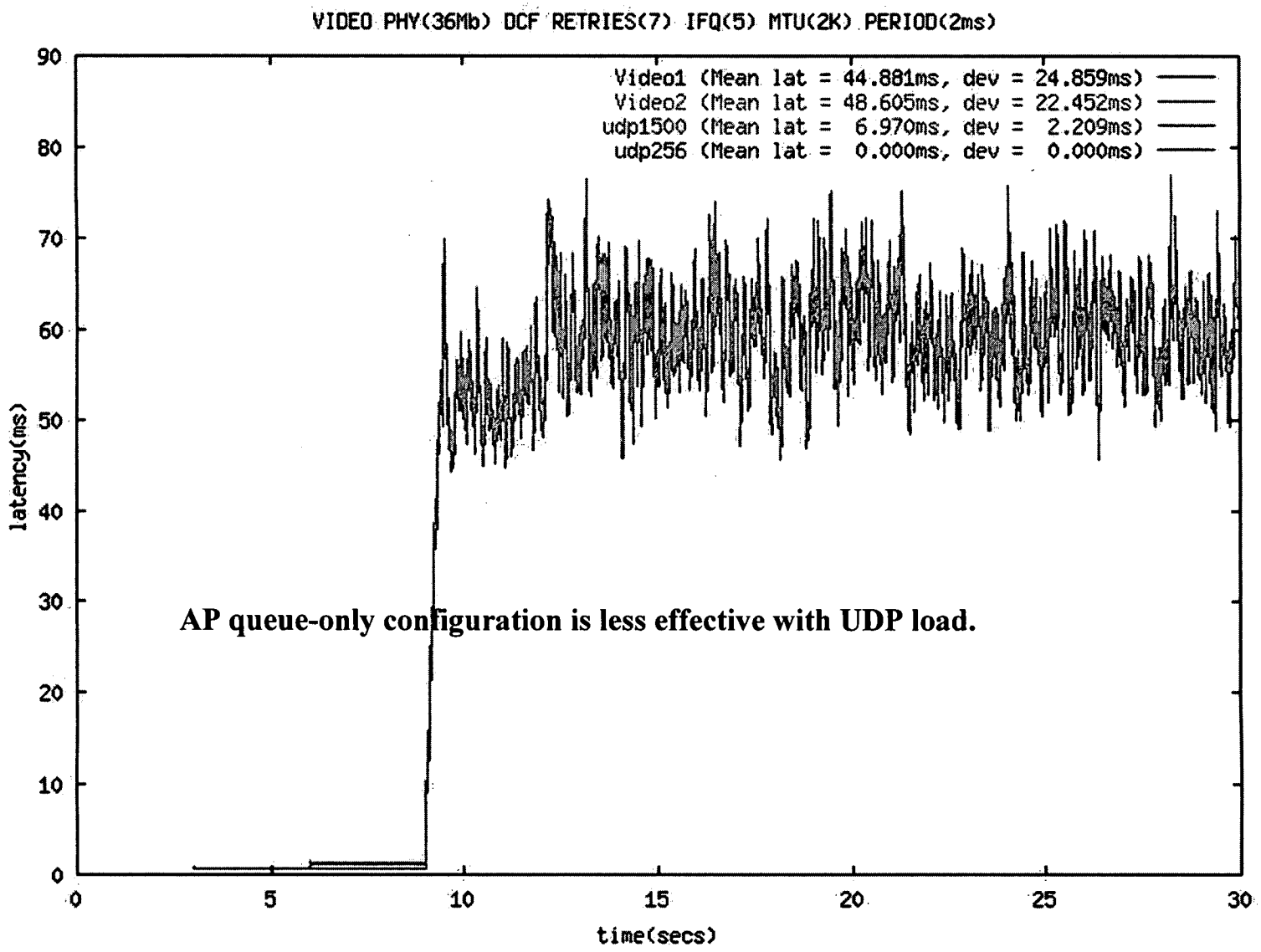
AP Scheduling

- Add priority packet scheduling to AP
- Video packets jump to head of queue(-5)
  - Assume 5 packets committed to hardware
  - Video can bypass all but 5


VIDEO PHY(36Mb) DCF RETRIES(7) IFQ(5) MTU(2K) PERIOD(2ms)
Video1 (IFQ/MAC drops = 0/0, Total b/w = 999.934KB/s)
Video2 (IFQ/MAC drops = 0/0, Total b/w = 999.893KB/s)
ftp1500 (IFQ/MAC drops = 0/0, Total b/w = 305.573KB/s)
ftp256 (IFQ/MAC drops = 0/0, Total b/w = 46.894KB/s)
Bandwidth(KB/s)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30
time(secs)
Bandwidth plot for AP priority queue-only configuration.
No other MAC QoS needed for this scenario.
Demonstrates capability of AP queuing to control traffic.
Majority of traffic passes through AP in many (but not all) environments.

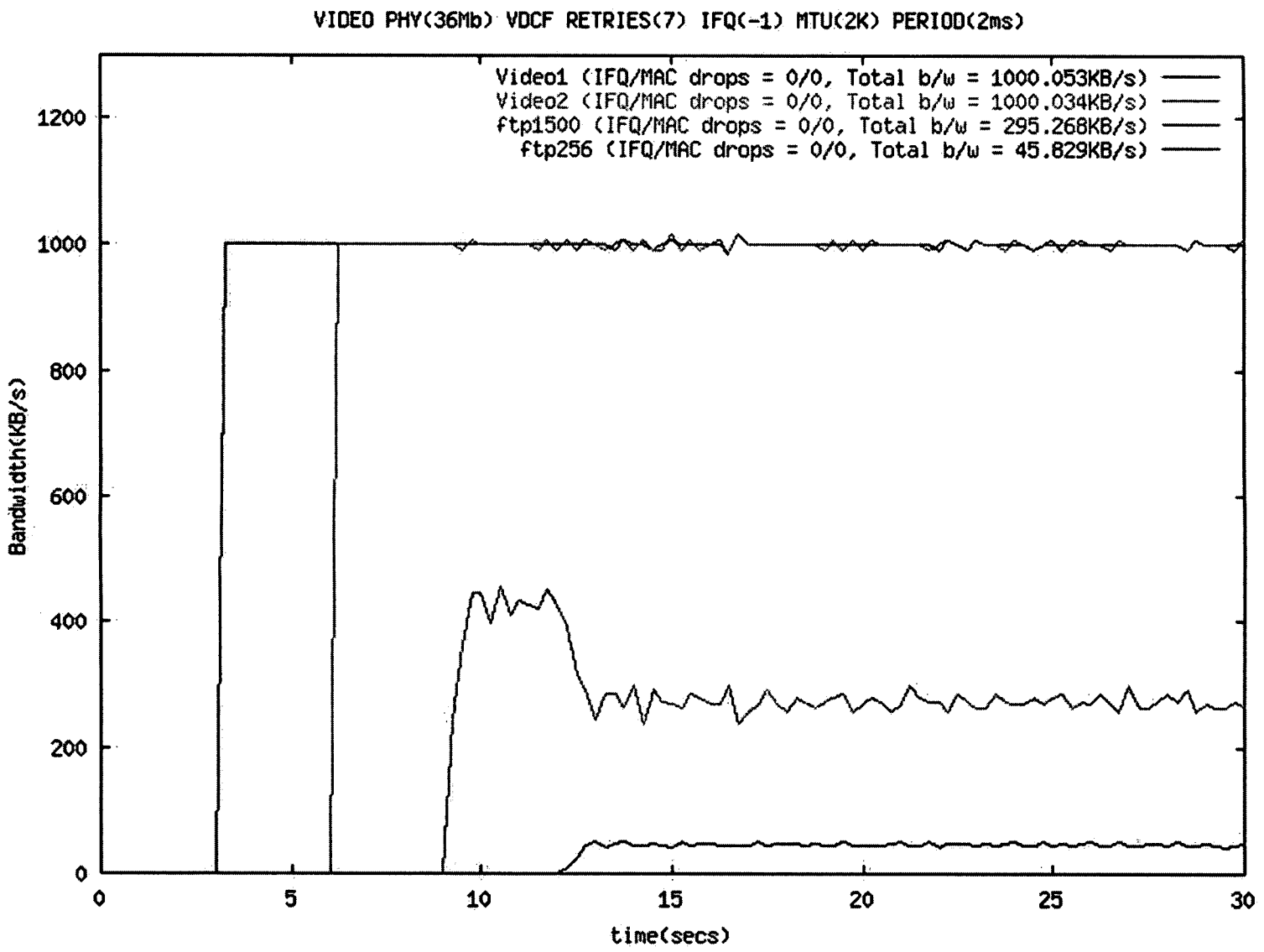


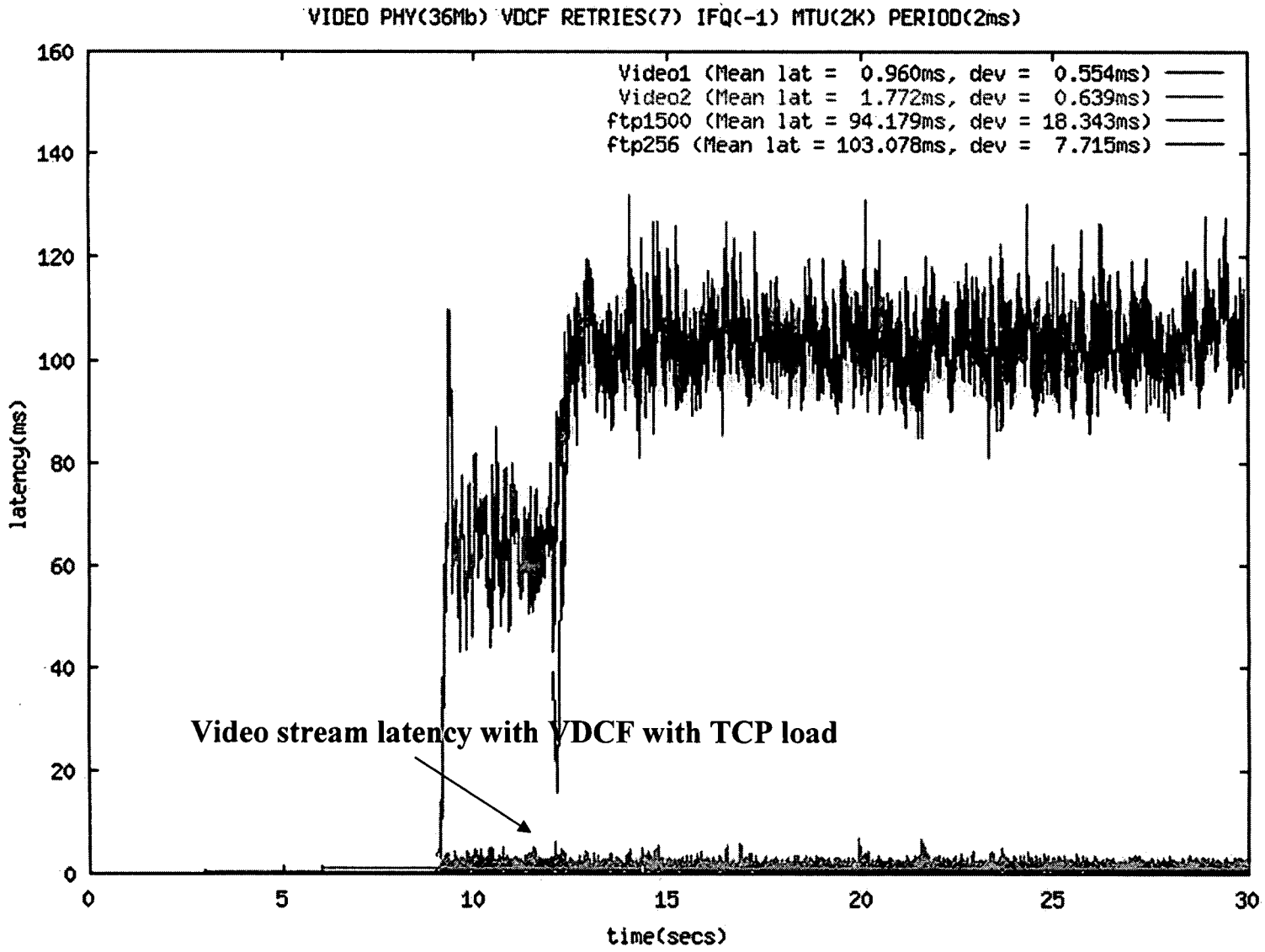
Latency with priority queue-only configuration.

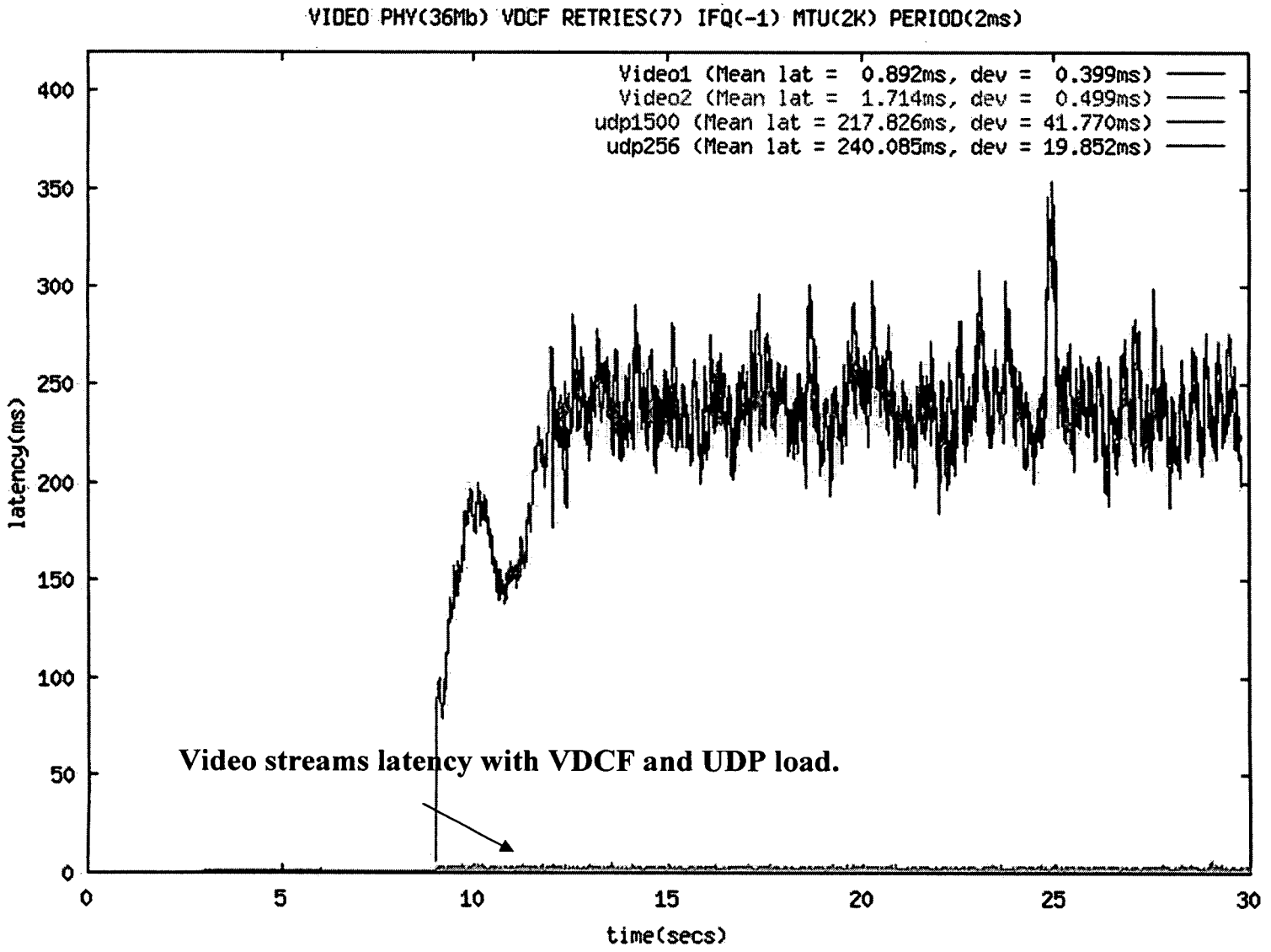

VIDEO PHY(36Mb) DCF RETRIES(7) IFQ(5) MTU(2K) PERIOD(2ms)
Video1 (Mean lat = 44.881ms, dev = 24.859ms)
Video2 (Mean lat = 48.605ms, dev = 22.452ms)
udp1500 (Mean lat = 6.970ms, dev = 2.209ms)
udp256 (Mean lat = 0.000ms, dev = 0.000ms)
latency(ms)
time(secs)
0
10
20
30
40
50
60
70
80
90
0
5
10
15
20
25
30
AP queue-only configuration is less effective with UDP load.

Adding VDCF

- TCP load
  - Increases bandwidth slightly
  - Improves latency
- UDP (raw) load
  - Provides differentiated bandwidth
  - Improves latency

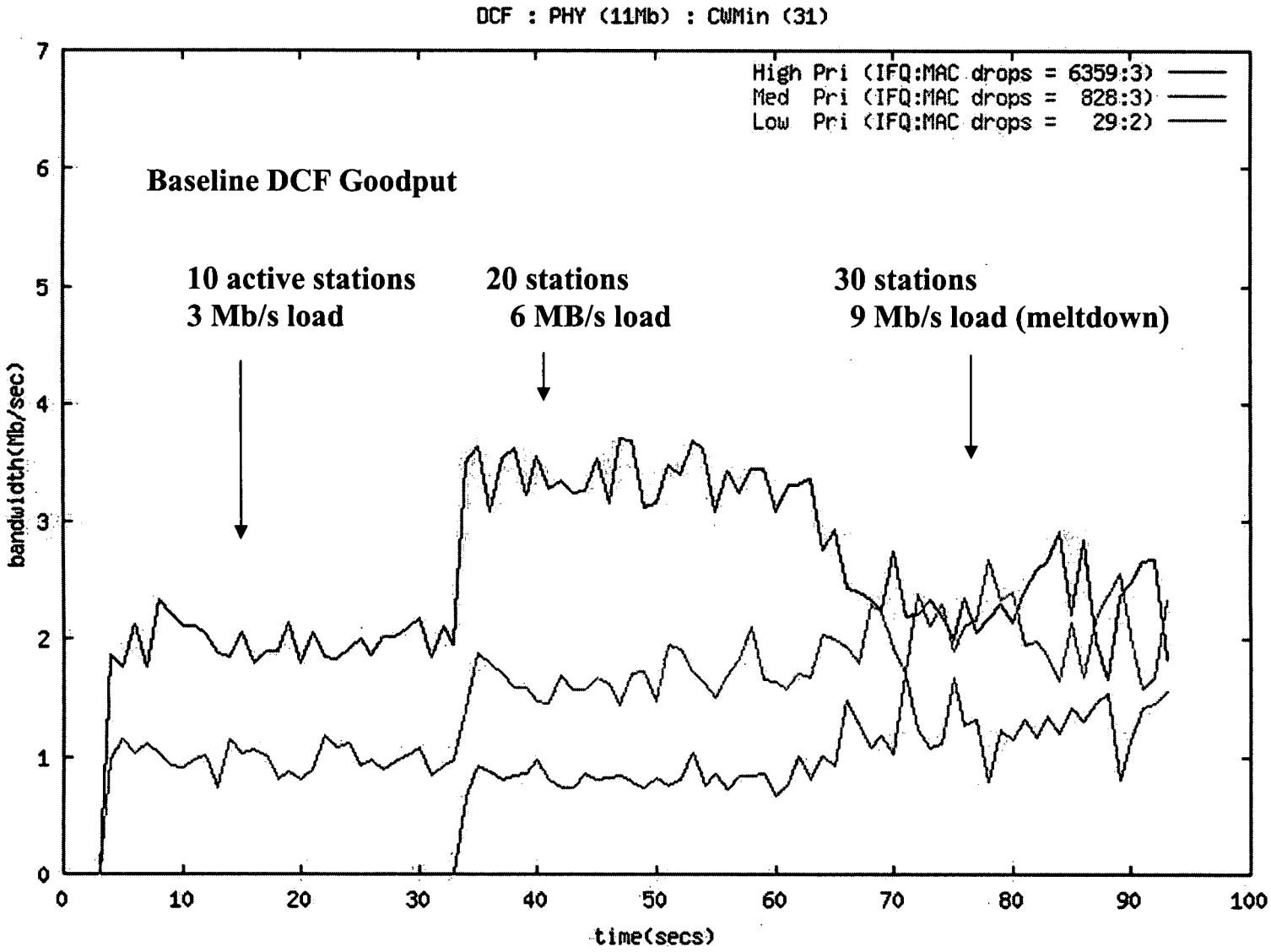

VIDEO PHY(36Mb) VDCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (IFQ/MAC drops = 0/0, Total b/w = 1000.053KB/s)
Video2 (IFQ/MAC drops = 0/0, Total b/w = 1000.034KB/s)
ftp1500 (IFQ/MAC drops = 0/0, Total b/w = 295.268KB/s)
ftp256 (IFQ/MAC drops = 0/0, Total b/w = 45.829KB/s)
Bandwidth(KB/s)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30
time(secs)

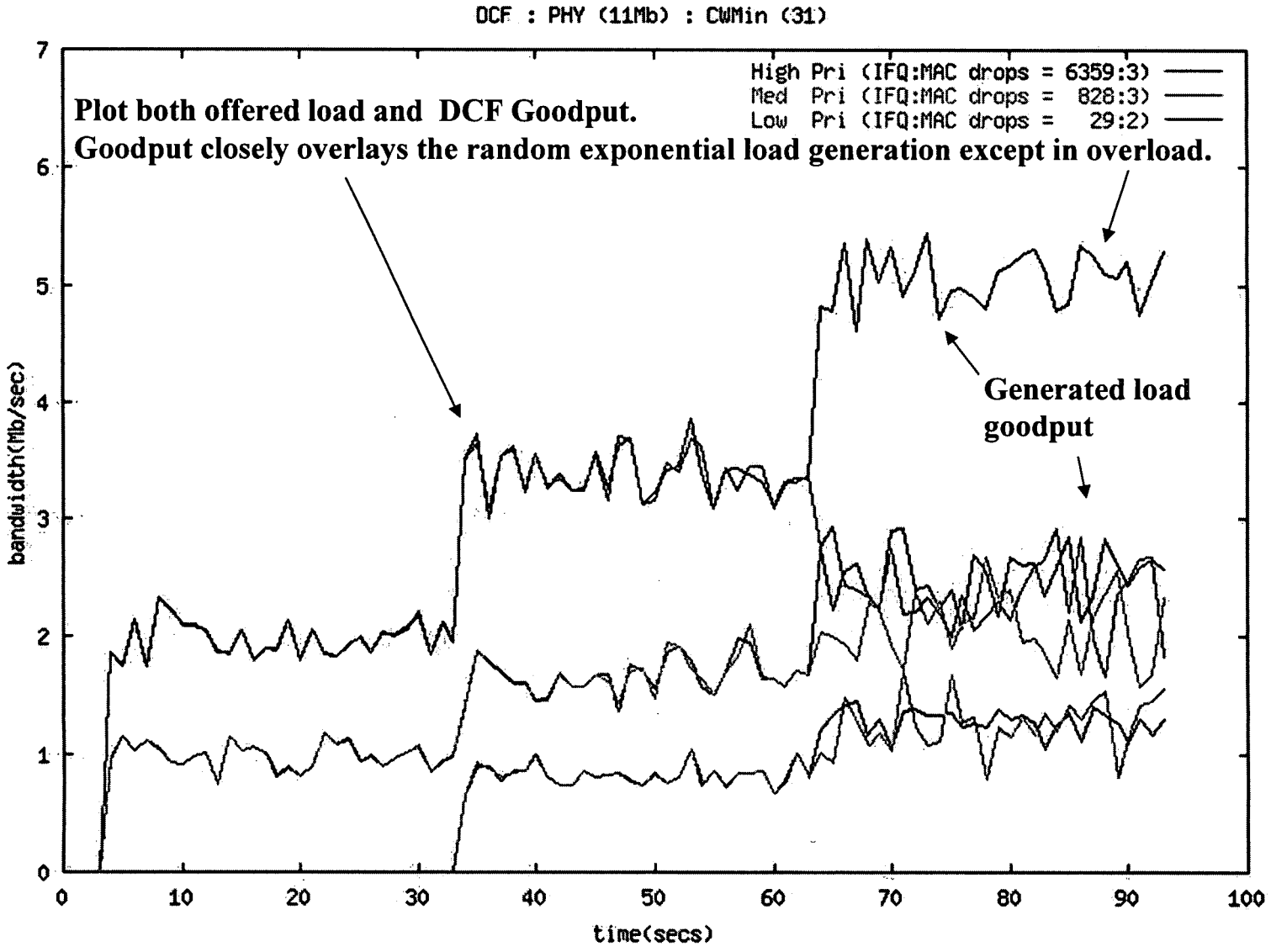

VIDEO PHY(36Mb) VDCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (Mean lat = 0.960ms, dev = 0.554ms)
Video2 (Mean lat = 1.772ms, dev = 0.639ms)
ftp1500 (Mean lat = 94.179ms, dev = 18.343ms)
ftp256 (Mean lat = 103.078ms, dev = 7.715ms)
latency(ms)
time(secs)
0
20
40
60
80
100
120
140
160
0
5
10
15
20
25
30
Video stream latency with VDCF with TCP load

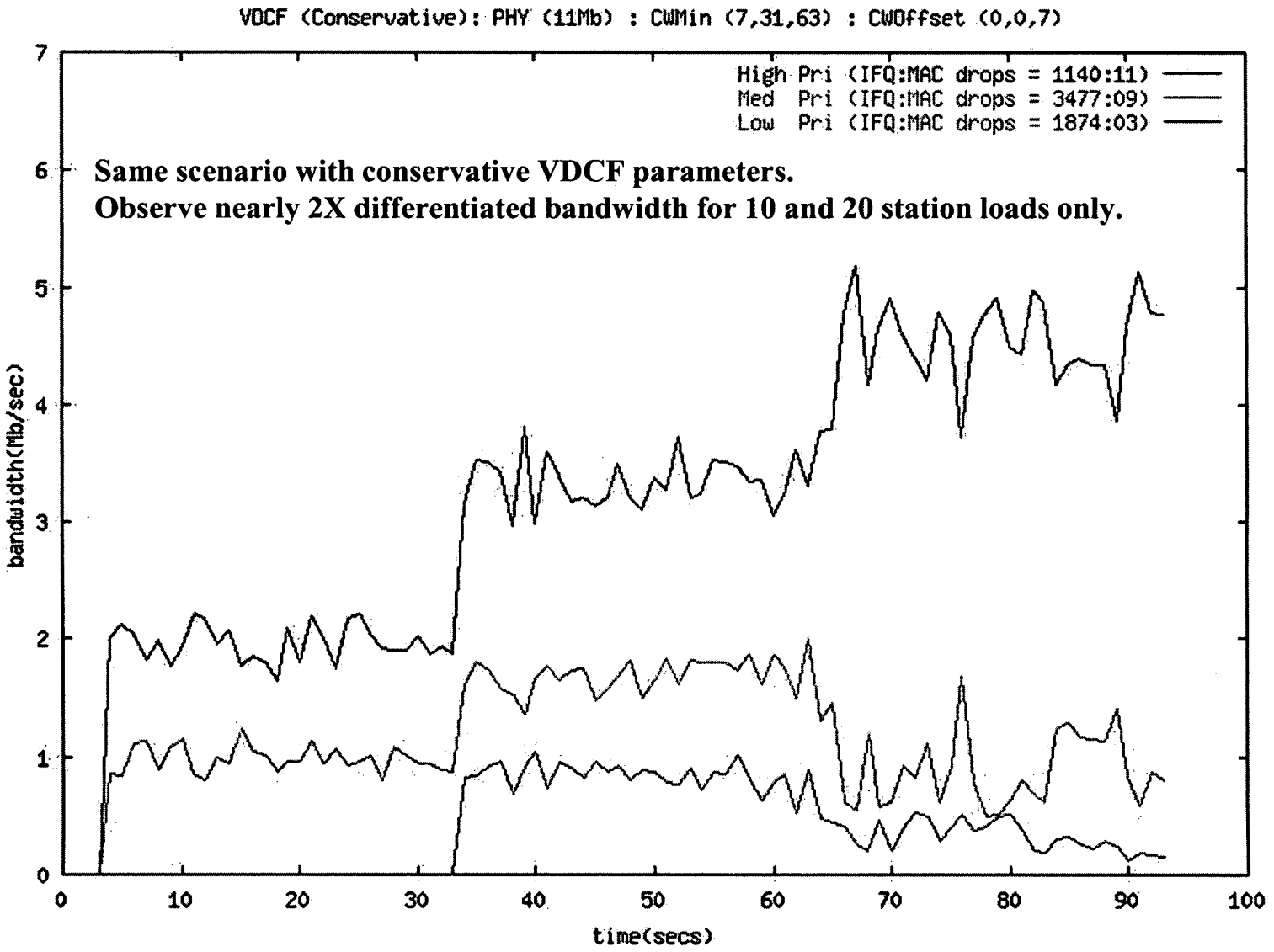

VIDEO PHY(36Mb) VDCF RETRIES(7) IFQ(-1) MTU(2K) PERIOD(2ms)
Video1 (Mean lat = 0.892ms, dev = 0.399ms)
Video2 (Mean lat = 1.714ms, dev = 0.499ms)
udp1500 (Mean lat = 217.826ms, dev = 41.770ms)
udp256 (Mean lat = 240.085ms, dev = 19.852ms)
latency(ms)
time(secs)
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
Video streams latency with VDCF and UDP load.

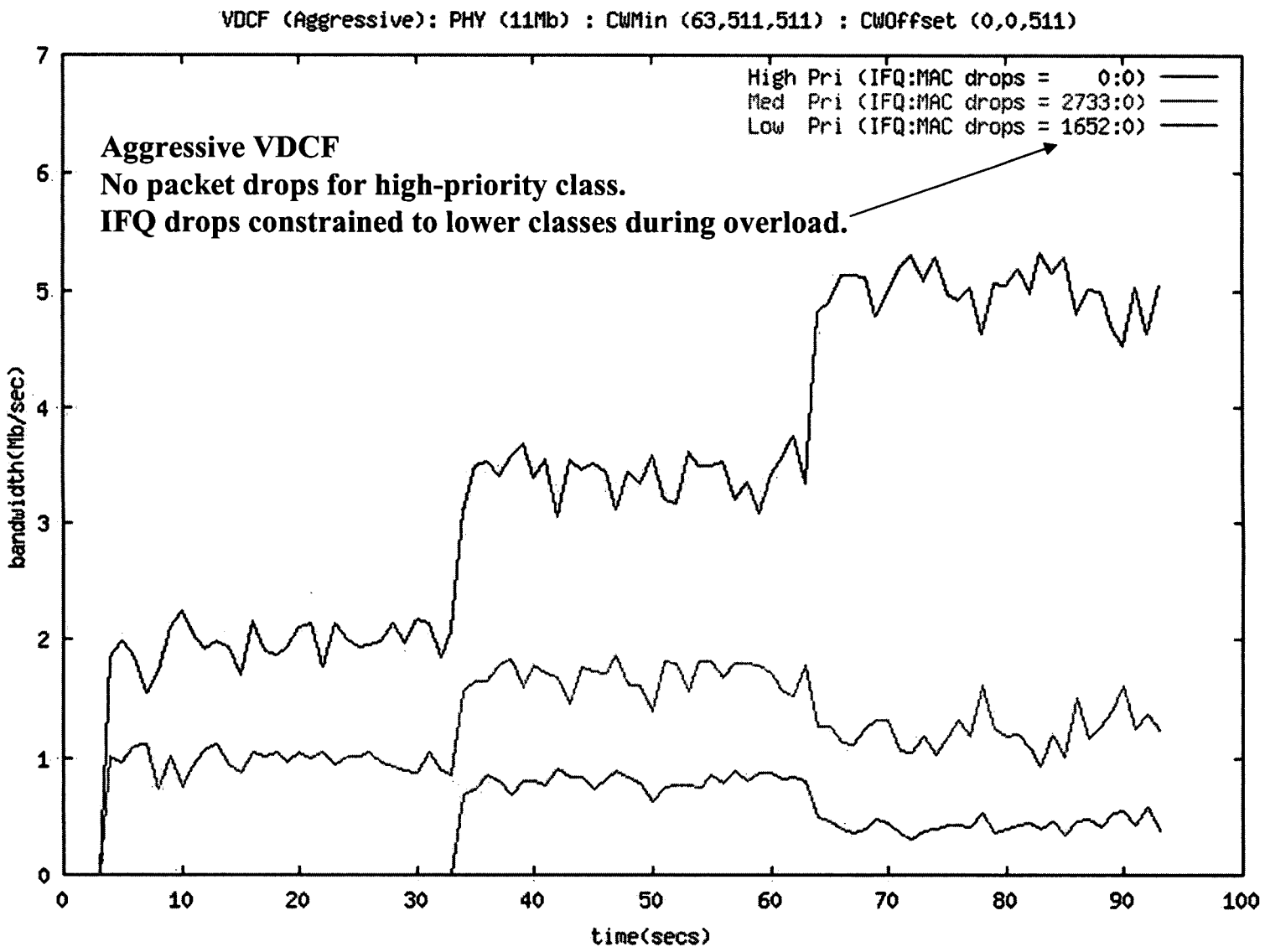
Sim Group Scenario

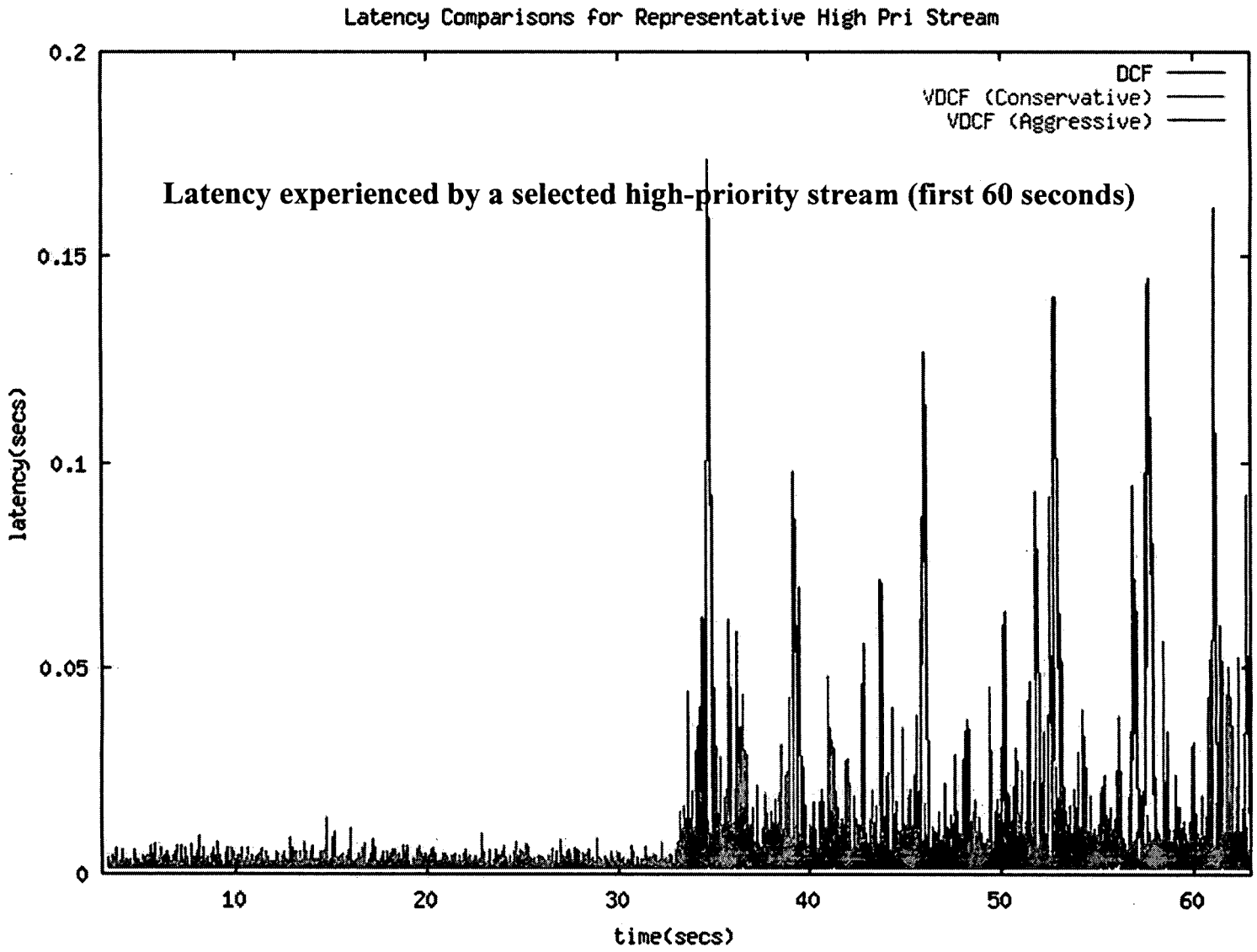
- 30 active stations on 11 Mb/s phy
  - 3 traffic classes: High, Medium, Low
  - Objective: 2/2/2 differentiated bandwidth
- Plot goodput, latency, drops for
  - DCF-only baseline
  - VDCF with two parameter sets
- 32 active stations
    - Add two stations in a 4th traffic class: X-High
    - Use PIFS instead of DIFS

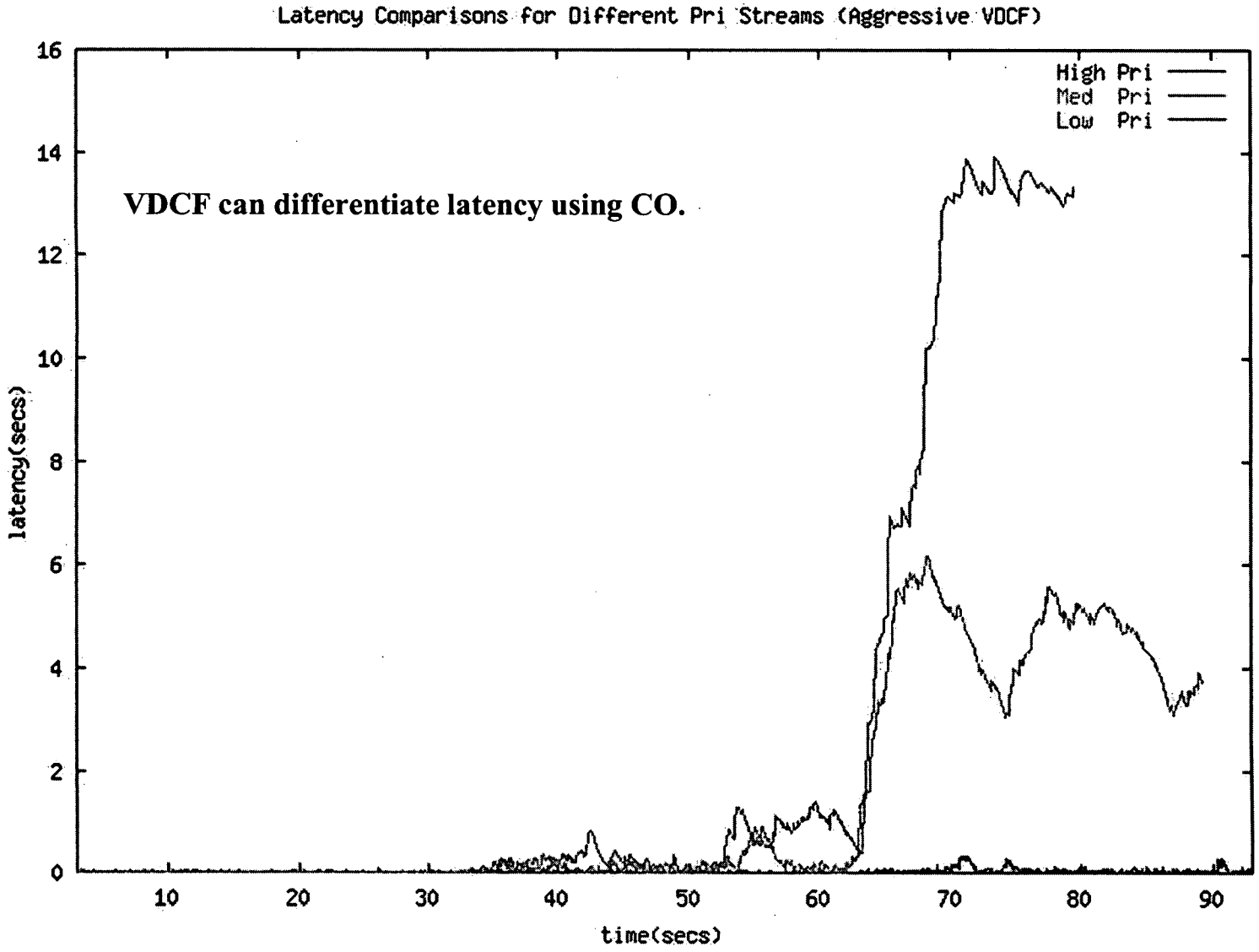

DCF : PHY (11Mb) : CWMin (31)
High Pri (IFQ:MAC drops = 6359:3)
Med Pri (IFQ:MAC drops = 828:3)
Low Pri (IFQ:MAC drops = 29:2)
Baseline DCF Goodput
10 active stations
3 Mb/s load
20 stations
6 MB/s load
30 stations
9 Mb/s load (meltdown)
bandwidth(Mb/sec)
time(secs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100


DCF : PHY (11Mb) : CWMin (31)
High Pri (IFQ:MAC drops = 6359:3)
Med Pri (IFQ:MAC drops = 828:3)
Low Pri (IFQ:MAC drops = 29:2)
Plot both offered load and DCF Goodput.
Goodput closely overlays the random exponential load generation except in overload.
Generated load goodput
bandwidth(Mb/sec)
time(secs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100


VDCF (Conservative): PHY (11Mb) : CWMin (7,31,63) : CWOffset (0,0,7)
High Pri (IFQ:MAC drops = 1140:11)
Med Pri (IFQ:MAC drops = 3477:09)
Low Pri (IFQ:MAC drops = 1874:03)
Same scenario with conservative VDCF parameters.
Observe nearly 2X differentiated bandwidth for 10 and 20 station loads only.
bandwidth(Mb/sec)
time(secs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100

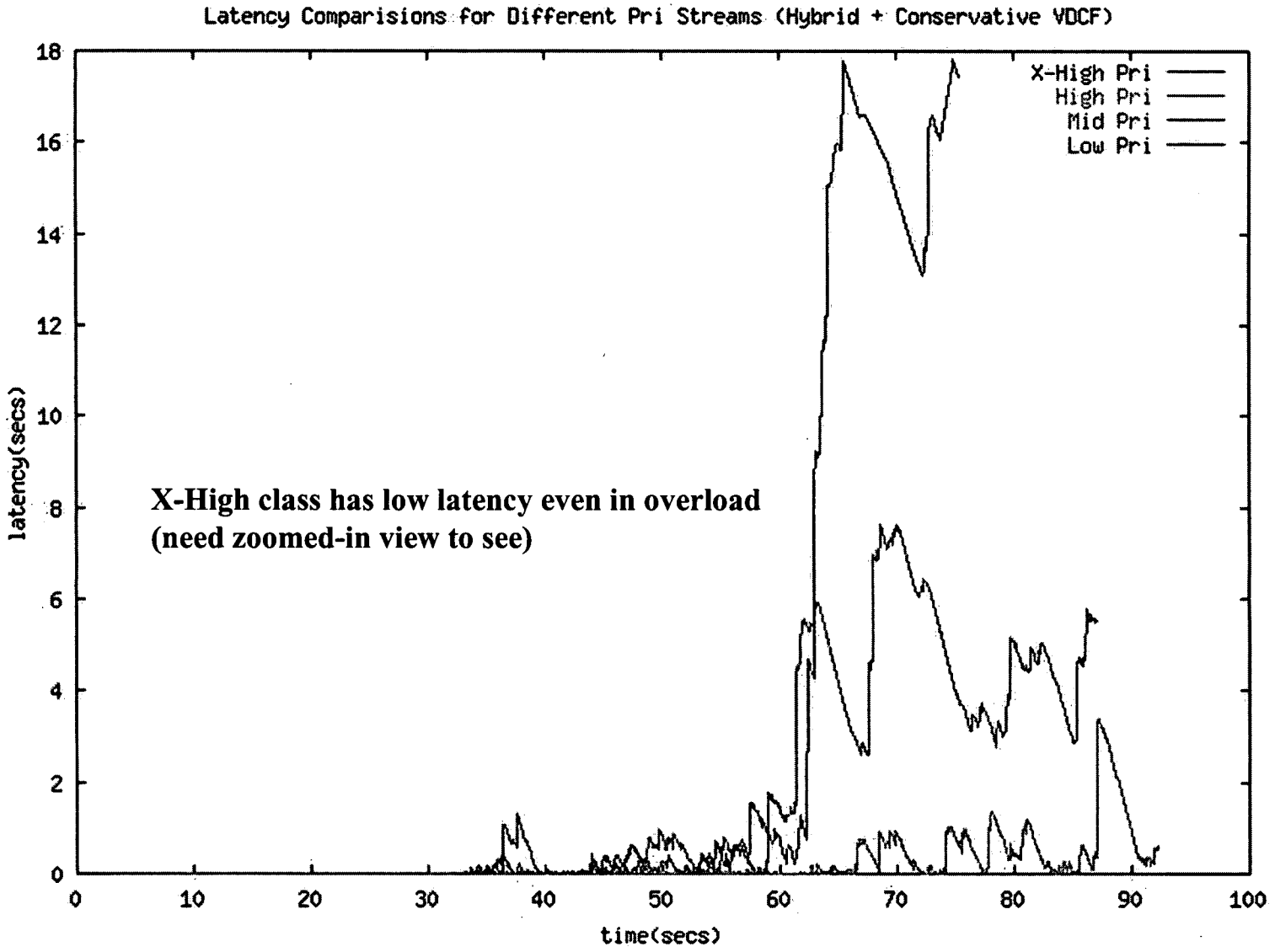

VDCF (Aggressive): PHY (11Mb) : CWMin (63,511,511) : CWOffset (0,0,511)
High Pri (IFQ:MAC drops = 0:0)
Med Pri (IFQ:MAC drops = 2733:0)
Low Pri (IFQ:MAC drops = 1652:0)
Aggressive VDCF
No packet drops for high-priority class.
IFQ drops constrained to lower classes during overload.
bandwidth(Mb/sec)
time(secs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100

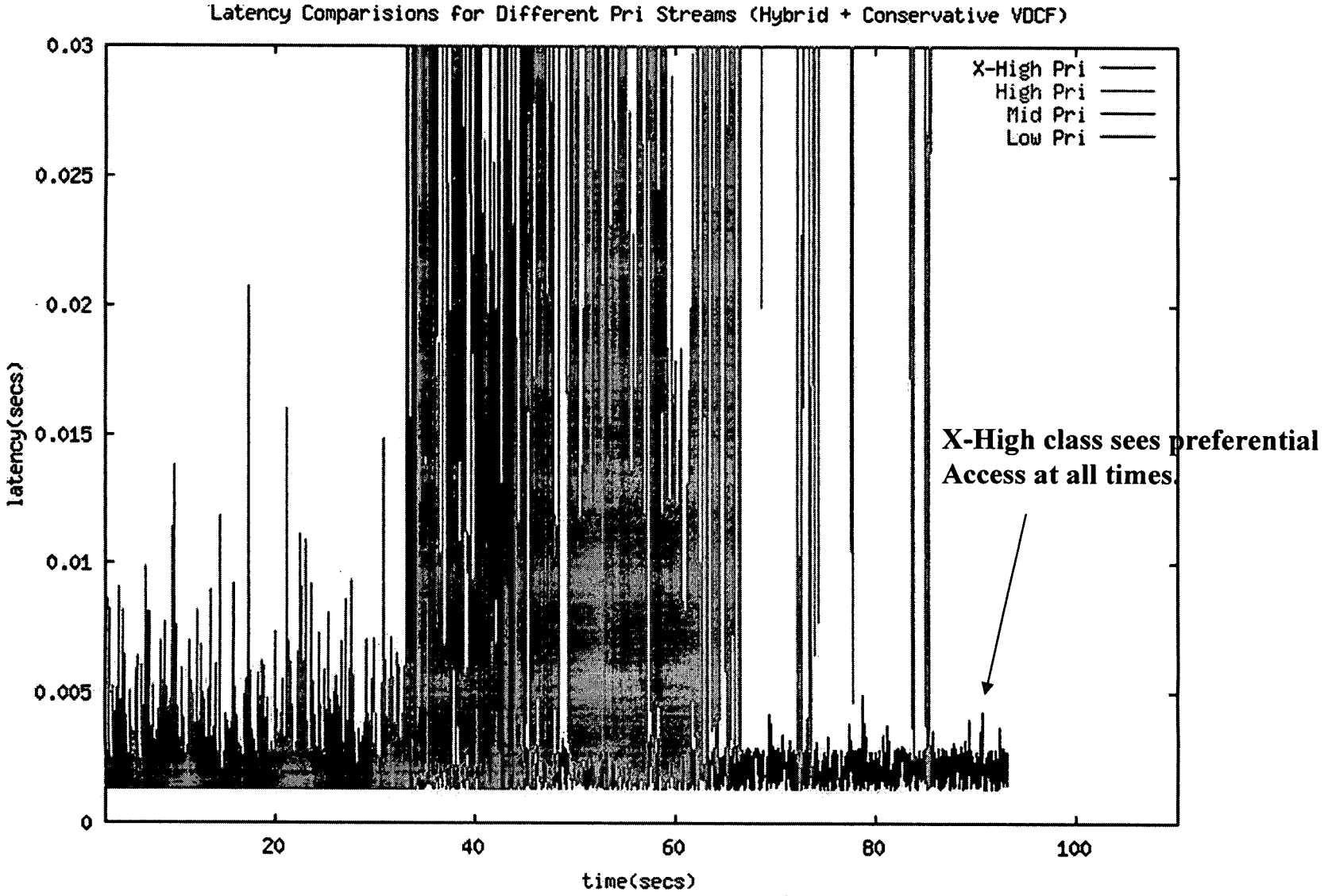

Latency Comparisons for Representative High Pri Stream
DCF
VDCF (Conservative)
VDCF (Aggressive)
Latency experienced by a selected high-priority stream (first 60 seconds)
latency(secs)
0.2
0.15
0.1
0.05
0
10
20
30
40
50
60
time(secs)


Latency Comparisons for Different Pri Streams (Aggressive VDCF)
High Pri
Med Pri
Low Pri
VDCF can differentiate latency using CO.
latency(secs)
time(secs)
0
2
4
6
8
10
12
14
16
10
20
30
40
50
60
70
80
90

PIFS

- Add two sources using PIFS rather than DIFS
- Each generates 1504 byte packets every 30ms


Latency Comparisions for Different Pri Streams (Hybrid + Conservative VDCF)
X-High Pri
High Pri
Mid Pri
Low Pri
latency(secs)
time(secs)
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
90
100
X-High class has low latency even in overload
(need zoomed-in view to see)


Latency Comparisions for Different Pri Streams (Hybrid + Conservative VDCF)
X-High Pri
High Pri
Mid Pri
Low Pri
latency(secs)
time(secs)
0.03
0.025
0.02
0.015
0.01
0.005
0
20
40
60
80
100
X-High class sees preferential Access at all times.

Conclusions

- VDCF provides differentiated bandwidth
  - using conservative parameters
  - Even in overload situation
- CO can influence latency differentiation between classes
- Constant CO/CW settings for each 90 second simulation:
  - Default (conservative) settings are useful
  - adaptation can improve performance
  - Real-time adaptation probably unnecessary with VDCF
- PIFS experiment demonstrates value for AP
  - For polling, other preferential access

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